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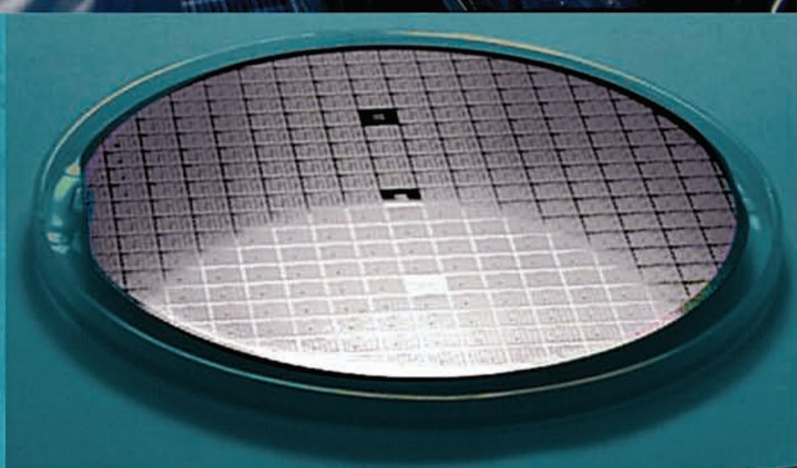
California Semiconductor Industry Hazardous Waste Source Reduction Assessment Report



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Department of Toxic Substances Control

DEPARTMENT OF TOXIC SUBSTANCES CONTROL

June 2006

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CALIFORNIA SEMICONDUCTOR INDUSTRY

HAZARDOUS WASTE SOURCE REDUCTION

ASSESSMENT REPORT

Prepared by
Relly Briones

State of California
California Environmental Protection Agency
Department of Toxic Substances Control
Office of Pollution Prevention and Technology Development

June 2006

This report was prepared by Relly Briones under the direction of Alan Ingham, Office of Pollution Prevention and Technology Development

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- Spectrolab
- Vitesse

DISCLAIMER

The mention of any products, companies, organizations or source reduction technologies, their source or their use in connection with material reported herein is not to be construed as either an actual or implied endorsement of such products, companies, or technologies.

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APPENDICES

I. INTRODUCTION

This report was prepared pursuant to the provisions of the Hazardous Waste Source Reduction and Management Review Act of 1989 (commonly referred to as SB 14). SB 14 requires the Department of Toxic Substances Control (DTSC) to select at least two categories of generators by Standard Industrial Classification (SIC) codes every two years to collect information on the source reduction progress and accomplishments of facilities within that industry, and to review the facilities' SB 14 documents for compliance. Exemplary source reduction approaches are included in reports, and disseminated back to generators within the selected industry.

SB 14 applies to generators that routinely generated over 12,000 kilograms (13.2 tons) of hazardous waste or 12 kilograms (26 pounds) of extremely hazardous waste during reporting years. Generators subject to SB 14 must identify their major hazardous waste streams and evaluate source reduction measures for each of their major wastes. Source reduction involves actions taken before waste is generated that would reduce the waste quantity and or the waste's hazardous characteristics. Generators are required to document source reduction accomplishments and plans to further reduce waste generation. The required SB 14 documents include:

a) Source Reduction Evaluation Review and Plan (Plan)
b) Hazardous Waste Management Performance Report (Performance Report)
c) Summary Progress Report (SPR)

The Plan is a forward looking document that includes the generator's evaluation of potential source reduction approaches that could be implemented to further reduce generated wastes. The Performance Report is a retrospective document that discusses the assessment of waste management approaches implemented since the baseline year, and serves as a way to share the positive efforts that improve the hazardous waste management at the site. The SPR summarizes information from the two previous documents. It reports the results of implementing source reduction measures, as well as the measures planned for implementation at certain dates. Of these three documents, only the SPR is required to be submitted to DTSC unless other documents are specifically requested. The generator must retain a copy of each of these documents at its site where they are available when requested by an inspector.

The intent of SB 14 is to promote hazardous waste reduction at the source and wherever source reduction is not feasible or practicable, to encourage recycling. Where it is not feasible to reduce or recycle hazardous waste, the waste should be treated in an environmentally safe manner prior to appropriate disposal to minimize the present and future threat to public health and the environment.

II. REPORT OVERVIEW

This report summarizes the results of DTSC's assessment of the semiconductor industry's source reduction efforts. This assessment was based on a review of selected companies' source reduction documents that were prepared pursuant to SB 14. Discussed in this report are source reduction measures implemented by various companies, and a presentation of industry waste generation practices over time. This report is the second SB 14 assessment of the semiconductor industry – the first assessment was published in October 1994.

DTSC used its Hazardous Waste Tracking System (HWTS) and the SB 14 SPR databases to determine which semiconductor companies are subject to SB 14, and which SB 14 documents to call in. Selection of facilities for document call-in was based on the quantity of waste manifested (per HWTS), and also on waste quantities reported in previous SPRs. The selected companies were asked to provide to DTSC their 1998 and 2002 SB 14 Plan and Performance Report.

Section III of this report is an overview of the major processing steps used in semiconductor manufacturing. An understanding of the manufacturing processes is important when examining the wastes generated and the waste reduction measures implemented.

Section IV includes a discussion of the industry's waste generation. It presents an overall picture of hazardous waste generation over time (1994 – 2002) based on the HWTS and SPR databases. The HWTS database reflects off-site hazardous waste management and is based on information contained in the waste manifests shipping documents (California Uniform Hazardous Waste Manifests). However, manifest data do not reflect the aqueous hazardous wastes that are treated on a generator's site and subsequently disposed to a publicly owned treatment works (POTW). To account for these aqueous wastes, staff used the information from the SPR database, which is based on SPRs submitted by companies subject to SB 14. It should be noted that HWTS converts volume units (gallons, cubic yards) to weight unit (tons) assuming values for the density of water (for liquids) or the density of soil (for solids). Actual weights could therefore be different from the HWTS converted weights.

When looking at industry source reduction progress, one must consider that the semiconductor industry is very dynamic. In the last decade, a number of major semiconductor companies closed their California semiconductor manufacturing facilities and moved their operations out-of-state (or country). Because of facilities closing, there was an absence of continuous comparable data over time. Therefore, it was difficult to obtain an accurate assessment of source reduction achievements across the industry. Another factor to consider when looking at the waste generation trends is the fast pace technology development which resulted in continual process operation changes, and therefore, variation in types and quantities of waste generated. Furthermore, the number of layers needed to form a desired circuit has a significant impact on the amount of waste generated. Because of increased circuit complexity, layers increased, and thus, also the waste quantity.

This report also contains a profile of selected semiconductor companies. The profile includes a discussion of the company's source reduction activities and its waste generation data in the years 1994 (if available), 1998, and 2002 as reported in their SB 14 source reduction documents. These profiles are presented in Section VIII.

In addition, all submitted SB 14 documents were reviewed for completeness. SB 14 requires specific information to be included in the reports to ensure that generators would have a thorough evaluation of their waste generation and source reduction processes. Section V discusses the results of the compliance review.

Section VI offers a discussion of management source reduction policies and commitment. To be successful, a source reduction program needs to be fully endorsed by management at all levels.

Section VII presents exemplary alternative source reduction approaches implemented by select semiconductor companies. Source reduction activities as applied to various waste streams were discussed. For the purpose of this report, wastes generated by the semiconductor companies were grouped under the following categories:

- Wastewater
- Solvents
- Corrosive liquids
- Contaminated debris.

III. OVERVIEW OF SEMICONDUCTOR FABRICATION PROCESS

Semiconductors are made of a solid crystalline material, usually silicone, and range from a simple diode to complex multi-layered integrated circuits. A simple diode is a single component circuit that performs the single function of regulating the flow direction of electrical current. Integrated circuits combine two or more components. Up to several thousand integrated circuits can be formed on a single wafer. The area on the wafer occupied by a single integrated circuit is called a chip or die.

The primary material used in the production of semiconductors is silicon, although other materials such as gallium arsenide can also be used depending on the intended application. The production of semiconductor devices starts with the introduction of elemental silicon (the seed) into sealed quartz ampoules that are then subjected to elevated temperatures and pressures. Silicon is gradually added to the initial seed in the ampoules which act as reaction chambers. This results in the formation of a cylindrical, crystal mass of silicon inside the ampoule. The resulting crystal is called an ingot. The silicon ingots are then cut into circular disks called wafers.

The next step is the buildup of electronic circuitry onto the wafer. This is conducted through a photolithographic process involving a series of etching, doping, and metallization steps. The electronic circuitry is built in a predetermined pattern depending on the ultimate use of the chip. Masked areas between these patterns prevent buildup of circuitry and thus provide cutting areas to separate the wafers into individual circuit groupings. The wafer is then cut into these groupings, which are called microchips.

A significant feature in producing semiconductor devices is the use of clean rooms that are engineered to minimize dust or other contaminants from landing on the wafers during fabrication. Dust and contaminants can cause malfunctions in the microscopic electrical circuitry. Such cleanliness is imperative since the effect of dust on one of these layers of circuitry can ruin an entire microchip.

This report focuses on the process of creating electrical circuitry on the silicon wafer. In general, the layers of circuitry are interconnected based on specifications developed as part of the ultimate application of the wafer. Therefore, even though the fabrication processes for the production of wafers can be explained in general terms, it must be noted that each production run and even different sections of the same run may follow different process flows and feature different types of equipment. The following is an overall discussion of the major processing steps and typical hazardous waste generation points of the semiconductor manufacturing process.

OXIDATION

Oxidation is the process of forming a thin film of silicon dioxide on the surface of a silicon wafer. Thermal oxidation takes place in a tube furnace with controlled, high temperatures and a controlled atmosphere. The oxidation reaction takes place between the silicon wafer and an oxidant gas such as oxygen or steam. The resulting silicon dioxide layer protects the wafer during further processing.

Materials used during oxidation include silicon dioxide, hydrofluoric acid, and solvents. Materials such as oxygen, hydrogen chloride, nitrogen, trichloroethane, and trichloroethylene may also be used. Wastes that may be generated from this process include silicon dioxide or other raw material being used for wafer fabrication, organic solvent vapors from cleaning gases, rinsewater with organic solvents from cleaning operations, spent solvents, and spent acids and solvents in the wastewater.

PHOTOLITHOGRAPHY

Photolithography is also known as photomasking or masking. This is the procedure used for transferring an image onto the surface of the wafer. This results in the formation of extremely small, accurate patterns on the wafer's silicon dioxide surface. The first step in the photolithography process is covering the wafer's oxide coating with a thin layer of photoresist. A spin track is used to apply a small quantity of photoresist onto the wafer, which is then spun at high speed on a rotating disk to uniformly coat the wafer surface. Some of the photoresist applied is flung from the wafer into the spin track tool and is collected as waste. The next step involves soft baking of the coated wafer in an oven for semi-hardening the deposited photoresist.

Ultraviolet (UV) light passing through a mask containing the circuit pattern determines where the light-sensitive polymer will be exposed. Patterns on the mask shield areas of the wafer from exposure to ultraviolet light. There are two different types of photoresists: positive and negative. The two photoresists differ primarily in the exposure process. Negative photoresists polymerize and stabilize upon exposure to ultraviolet light, while positive photoresists behave in a reverse manner, that is, they are made more soluble after exposure to UV light. After photolithography, chemical developers are used to remove unhardened resist that was exposed (for positive photoresist) or unexposed (for negative photoresist) to UV light. Development may be performed on spin tracks, in sinks, or in enclosed spray units. Developers may be a solvent-based chemical or an aqueous-based solution.

Wastes generated from the photolithographic process include hexamethyldisilane (HMDS) which is typically used as an initial coating on the wafer's oxide surface to increase the adhesion of photoresist. Waste photoresist solvents and developers also result from this process.

Some spin tracks are integrated tools where a variety of different materials (photoresist, edge bead remover, spin-on-glass, etc.) may be applied. Spin-on glass is a non-light sensitive coating which acts as a protective layer or which provides a good adhesive surface for subsequent layers. Edge bead remover is a solvent, which is spun onto a coated wafer to remove the photoresist bead, which forms on the outside edge of a coated wafer. Spin tracks may use automatic cleaning wherein solvent, typically isopropyl alcohol (IPA), acetone, or propylene glycol methyl ether acetate (PGMEA) is dispensed onto the spin track to prevent photoresist buildup. Manual wipe cleaning of spin tracks is also performed, typically with an IPA solution.

ETCHING

Etching is used to remove the oxide, nitride, or other selected layers not covered by photoresist. This process exposes the silicon surface in preparation for doping with impurities. The etching process is conducted as either wet chemical etching (using acids), or as dry/plasma etching (using reactive gas plasma). Historically, wet chemical etchers were more commonly used. However, plasma etching processes are now becoming more popular.

Waste sulfuric, hydrofluoric, hydrochloric, phosphoric, nitric, and chromic acids are produced as a result of etching process. Buffered oxide etch (BOE - consisting mainly of hydrofluoric acid and ammonium fluoride) and waste lubricating oils from vacuum pumps used to evacuate the reaction chambers of the plasma etchers are also generated during the etching process.

PHOTORESIST STRIPPING

After the etching operation, remaining photoresist on the wafer is removed using a photoresist stripper. Photoresist stripping can be accomplished either by ashing or wet stripping. Ashing is a gas phase process utilizing a plasma environment, while wet stripping is a liquid phase process utilizing either solvents or acid depending on the layers.

DOPING

Doping is the introduction of a dopant, which contains impurity atoms with specific behavior patterns. Dopants are applied to the patterned wafer surface typically using diffusion or ion implantation. In diffusion, dopants are deposited onto the wafer by stacking the wafers in a long, heated quartz tube and exposing them to gases containing impurities that diffuse into the exposed parts of the wafer. Ion implantation provides a greater control of the location and concentration of dopants and is conducted by bombarding the wafer with ionized impurities in a vacuum chamber. Dopant gases used include arsine, silane, phosphine, and diborane. Wastes generated from this step consist of solid wastes containing arsenic, antimony, phosphorus, arsine, diborane, mixed acids, and waste vacuum pump oils. Acids are used in wet bench baths for equipment cleaning and maintenance.

LAYERING

Depending on the design of the microprocessor, there could be several layers formed on a wafer. The layering, photolithography, etching, and doping processes are repeated, building the transistors and other electronic circuitry that make up the chip on a wafer.

Additional layers of silicon or silicon dioxide may be applied to the wafer using deposition techniques, typically epitaxial growth or chemical vapor deposition.

Epitaxial growth is the process of re-establishing a fresh silicon layer on a wafer using exposed silicon on the wafer surface as a seed for additional silicon crystal growth. Epitaxial growth occurs in an epitaxial reactor where the wafer is exposed to silane and dopant gases in a high temperature environment. Silicon layer growth is also performed with molecular beam epitaxy, in which silicon and dopants are evaporated and deposited on the wafer in a vacuum environment.

Chemical vapor deposition (CVD) is a process in which a metal or silicon compound is vaporized and deposited onto the wafer as a thin film. CVD is a low pressure process that combines appropriate gases in a reactant chamber at elevated temperatures to produce a uniform film thickness.

Materials used during deposition include silane, silicon tetrachloride, ammonia, nitrous oxide, tungsten hexafluoride, arsine, phosphine, diborane, nitrogen, and hydrogen.

After each layering or other coating process, chemical mechanical polishing (CMP) is performed to re-establish the wafer flatness required for subsequent processing steps. CMP is usually performed with inorganic abrasive slurries.

METALLIZATION, FINAL LAYERING AND CLEANING

Once the wafer is patterned, the wafer surface is coated with thin layers of metal by a process called metallization. These metal layers perform circuit functions within the finished semiconductor, by making contact at any place where bare silicon exposes the circuit device. Two types of metallization are sputtering and high vacuum evaporation.

Sputtering (also called partial vacuum evaporation) is a physical, rather than chemical process. This process occurs in a vacuum chamber which contains a target (solid slab of the film material) and the wafers. Ionized gas atoms, typically argon, is impinged on the metal target in order to generate microscopic metal fragments which are deposited on the wafer as a thin film.

High vacuum evaporation is a process that uses an electron beam, a ceramic bar heated by thermal resistance, or a wire heated by electrical resistance. This method coats the surface of the wafer with metal.

A final layer of silicon dioxide or silicon nitride is then applied over the wafer surface, which provides a protective seal over the circuit. This process, called passivation, protects the semiconductor from exterior influences and also insulates the chip from unwanted contact with other external metal contacts.

After all layers have been applied to the wafer, the back of the wafer is mechanically ground (also called lapping or back grinding) to remove unnecessary material. A film of gold may be applied to the back of the wafer by an evaporation process to aid the connection of leads to the bonding pads during a later process step.

IV. SEMICONDUCTOR INDUSTRY WASTE GENERATION

In determining the effectiveness of the industry's source reduction efforts, we presented in Table I the quantity of wastes generated from 1994 to 2002. Measuring pollution prevention successes industry-wide is a difficult task. The graphical trend that shows aggregated waste generation from various companies does not tell the reader the different dynamic operations involved in each facility. The more specific and focused the analysis is, the more accurate the result will be. We therefore included in this report profiles of selected companies to provide an overall description of the facility as well as the source reduction results accomplished by those companies.

We used DTSC's HWTS data to determine the amount of wastes manifested by companies under North American Industry Classification System (NAICS) 334413, which is the nearest industry equivalent of the SIC 3674. We also used the SPR database to further check the waste quantities reported by facilities in their SPRs that were submitted to DTSC in compliance with SB 14 reporting requirements. Since SB 14 reporting is every four years, the SPR waste data shown are for the reporting years 1994, 1998, and 2002.

Note that both of these databases have limitations. HWTS will automatically convert volume units to weight units (tons). Solid volumes are converted to tons using a density estimate for soil, and liquid measurements are converted to tons using a density equal to water. These conversion factors may potentially yield erroneous weight values for many wastes.

When comparing the SPR database waste generation quantities for the reporting years (1994, 1998, 2002), please note that some facility waste streams might not be considered major waste streams[1] for some years, but were major waste streams for other years. This will yield a deceiving result by showing nothing generated on the year when the waste stream was not major, and suddenly will indicate a significant quantity on the years for which the waste stream was determined to be major. Also, some facilities just started submitting their SPRs. These facilities would show newly generated wastes for the current reporting year, and none for previous years.

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[1] Major wastes are those waste streams that account for more than five percent of the facility's total generated waste. Please note that determining a major waste stream requires more than a simple five percent calculation. Major waste streams can fall under one of three categories:

- Category A: hazardous wastes that are processed through an on-site wastewater treatment unit prior to discharge to a publicly owned treatment works (POTW) or to a receiving water under a National Pollution Discharge Elimination System (NPDES) permit.
- Category B: all other hazardous wastes that is not processed in a wastewater treatment unit.
- Category C: all wastes that are classified as extremely hazardous wastes.

Please refer to the "Guidance Manual for Complying with the Hazardous Waste Source Reduction & Management Review Act of 1989" (December 2002) for a more detailed discussion in determining major wastes.

There are several factors to consider when looking at the waste generation quantities. Changes in manufacturing operations would correspondingly affect the amount of wastes generated. The semiconductor industry is a very dynamic industry. The need to maintain technological advancement necessitates process changes that may result in new types of wastes generated and can simultaneously increase waste quantities. New product designs may call for more layers on the chip, thus requiring additional processing, etching, and rinsing which generate additional wastes. Since processes continually change, process equipment may only be used for a few years, and then replaced with new tools. Some companies have closed, while new companies have started. These dynamics make it more difficult to make an accurate industry-wide assessment of the success of the industry's source reduction efforts.

In the absence of a better normalizing method, this report used the Gross State Product for the electronic industry as the basis for normalizing. Table I shows the Gross State Product reported in the Department of Finance's statistical report (http:// http://www.dof.ca.gov/HTML/FS_DATA/STAT-ABS/StatAbstrct2003www.pdf) together with the waste quantities generated by semiconductor facilities.

TABLE 1. QUANTITY OF WASTES GENERATED, 1994 – 2002

	HWTS Wastes,[1] Tons	**GDSP,[2] millions in current dollar**	**Pounds (HWTS Waste) per Ten Billion Dollars in GDSP**	**SPR Wastes,[3] Tons**
1994	14,323	19,364	7,397	8,160
1995	15,808	23,958	6,598	
1996	15,621	25,248	6,187	
1997	14,393	29,235	4,923	
1998	13,291	27,459	4,840	8,950
1999	15,732	28,091	5,600	
2000	17,813	29,867	5,964	
2001	16,902	24,565	6,881	
2002	13,416	No data		11,809

[1] Total wastes from DTSC's HWTS database not including wastes listed under CWC 151 (Asbestos-containing wastes), CWC 261 (PCBs and materials containing PCBs), and CWC 611 (Contaminated soil from site cleanup).

[2] From the Department of Finance website: (http://www.dof.ca.gov/HTML/FS_DATA/STAT-ABS/StatAbstrct2003www.pdf)

[3] Total wastes from the SPR database not including hazardous wastewater that was treated onsite and discharged to a POTW.

Figure 1 is a graphical presentation of Table 1.

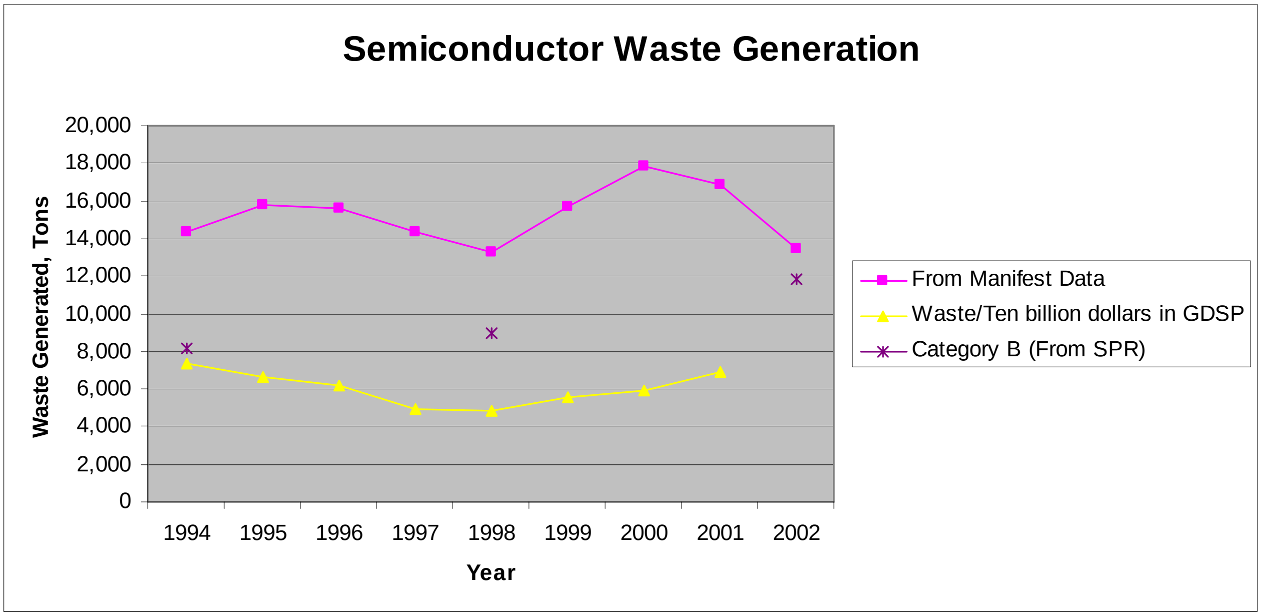

FIGURE I. GRAPH OF WASTES GENERATED BY NAICS 334413 (SEMICONDUCTOR INDUSTRY)

The waste generation trend for the semiconductor industry hovered around the 15,000 tons area from 1994-2002. Again, one needs to consider the different factors that affect waste generation. Figure 1 did not reveal the significant reduction in waste generation that semiconductor companies reported in their SB 14 documents. As an example, Figure 1 did not reflect NEC Electronics America's reduction of its condensate-contaminated wastes by nearly one million pounds. One should note then that even though there may be an increase in wastes generated from certain process areas, companies had successfully implemented source reduction measures on other process operations. Collectively, semiconductor companies reported in their SPRs a total waste reduction using source reduction practices of about 128 million pounds when comparing 1998 with 2002 quantities.

Table 2 shows the California Waste Codes (CWCs) generated by the industry as reported on their SPRs. Table 2 was sorted based on waste quantities generated in 2002. Please note that the CWCs range from somewhat specific to very general. The generator enters the CWC most applicable to the wastes being shipped. The accuracy of CWC reported in the manifest depends on the experience or knowledge the user has concerning selecting the most descriptive CWC. Two different people can potentially use two separate waste codes to classify the same waste stream. Table 2 shows that the wastewater-related CWCs are the most generated waste streams, followed by solvents or solvent-contaminated debris.

TABLE 2. CALIFORNIA WASTE CODES (CWC)

CWC	DESCRIPTION	1998			2002		
		A	B	1998 TOTAL	A	B	2002 TOTAL
CWC 131	Aqueous solution (2<pH<12.5) with reactive ions	5,264,811,261	187,811	5,264,999,072	5,429,834,090	300,374	5,430,134,464
CWC 135	Unspecified aqueous solution	1,222,489,885	64,358	1,222,554,243	1,732,798,871	1,141,517	1,733,940,388
CWC 134	Aqueous soln with total organic residues <10%	756,004,196	29,340	756,033,536	894,335,718	86,264	894,421,982
CWC 791	Liquids with pH < or = 2	300,730,005	360,320	301,090,325	325,426,083	269,481	325,695,564
CWC 132	Aqueous soln with metals (restricted levels)	281,407,776	52,447	281,460,223	309,000,892	92,754	309,093,646
CWC 122	Alkaline soln (pH > or = 12.5) with metals	520,428	5,647,503	6,167,931	601,352	5,653,594	6,254,946
CWC 721	Liquids with arsenic > or = 500 mg/L			0		4,401,698	4,401,698
CWC 352	Other organic solids		4,480,327	4,480,327		4,133,284	13,093,938
CWC 222	Oil/Water separation sludge			0		3,268,880	3,268,880
CWC 212	Oxygenated solvents (acetone, butanol, etc.)		1,346,979	1,346,979		1,416,480	1,416,480
CWC 792	Liquids with pH < or = 2 with metals		940	940	1,264,035	4,034	1,268,069
CWC 214	Unspecified solvent mixture		866,458	866,458		872,973	872,973
CWC 343	Unspecified liquid organic mixture		553,861	553,861		588,494	588,494
CWC 213	Hydrocarbon solvents		146,445	146,445		379,923	379,923
CWC 741	Liquids with HOC > or = 1000 mg/l		1,137,340	1,137,340		378,343	378,343
CWC 221	Waste oil and mixed oil		1,702,020	1,702,020		248,680	248,680
CWC 123	Unspecified alkaline soln	180,094		180,094	218,591		218,591
CWC 711	Liquids with cyanides > or = 1000 mg/l	132,643	86,684	219,327	91,101	60,674	151,775
CWC 171	Metal sludge		146,060	146,060		148,000	148,000
CWC 223	Unspecified oil-containing waste		21,150	21,150		123,600	123,600
CWC 728	Liquids with Thallium > or = 130 mg/l			0		38,535	38,535
CWC 551	Laboratory waste chemicals		449	449		6,809	6,809
CWC 141	Off-spec, aged, or surplus inorganics			0		2,840	2,840
CWC 331	Off-spec, aged, or surplus organics		500	500		1,117	1,117
CWC 252	Other still bottom waste			0		800	800
CWC 321	Sewage sludge			0		150	150
CWC 121	Alkaline solution		667	667			0
CWC 133	Aqueous soln with total organic residues > or = 10%		1,040,000	1,040,000			0
CWC 211	Halogenated solvents		18,500	18,500			0
CWC 726	Liquids with nickel > or = 134 mg/l		10,000	10,000			0
TOTAL		**7,826,276,288**	**17,900,159**	**7,844,176,447**	**8,693,570,733**	**23,619,298**	**8,726,150,685**

V. COMPLIANCE WITH SB 14

Although most of the semiconductor companies' SB 14 documents generally addressed the SB 14 requirements, the following findings reflect areas where the documents had deficiencies. Some of these deficiencies are very minor and easily correctable. When deficiencies are noted on SB 14 documents, DTSC staff informs the facility through written communication of the deficiencies and suggested corrections.

- No discussion of rationale for rejecting considered source reduction measures. Facilities would list potential source reduction measures for evaluation, but in their selection of the ones that they would implement, there would be no explanation why some measures considered were not selected.

- No Environmental Protection Agency Identification (EPA ID) number. Although a minor oversight, this information is important since the EPA ID number ensures correct facility identification.

- Vague description of source reduction measures. Some facilities, in their discussion of the source reduction activities implemented, would just mention implementing process changes, without sufficient description that would give a clear understanding of the measures implemented. We recognize that there may be proprietary information that the facility may not want to divulge, but facilities can often present a more descriptive discussion without compromising security.

- No numerical goal. The goal reflects the facility's source reduction vision and commitment. The goal is an estimate of the source reduction that the site could optimally strive to achieve over a four-year period with adequate resources and committed management. Although facilities will not be considered non-compliant if this goal is not attained, facilities should endeavor to put their best effort to formally recognize what is possible under optimal conditions and then challenge themselves to strive for this goal.

- Not properly certified. Financial certifications need to use the mandated language pursuant to Title 22 California Code of Regulations (CCR) Section 67100.13(e).

- No description of waste-generating processes. The Plan should contain sufficient information to enable an outside reader to understand the overall flow of materials between unit processes. This is an important element of the Plan for the reader to know how and where the wastes are generated. A block flow diagram illustrating the waste-generating processes is also required to be included in the Plan.

- No timetable for implementing selected source reduction measures. For each of the selected source reduction measures, a schedule should be provided to indicate the expected dates and milestones by which the chosen measures will be implemented.

The intent is to improve reporting by detailing the common deficiencies on SB 14 reports and thus, improve facilities' documents. Staff will present these deficiencies at SB 14 compliance training events and consider including them in the SB 14 Guidance Manual on its next revision.

VI. COMPANY SOURCE REDUCTION PROGRAMS

The following companies included in their SB 14 documents a discussion of their corporate programs that commit facility resources to source reduction. Only a number of companies provided sufficient details, and this could be because SB 14 does not specifically require generators to discuss in the reports their company's philosophy or their management's source reduction involvement. It does not necessarily mean that companies not mentioned in this report do not have policies in place, but that discussion of these policies were not included in their SB 14 documents.

INTEL CORPORATION

Intel's Chemical and Natural Resource Strategic Chemical Services (C&NR SCS) is a senior management review board that works on improving the environmental, health and safety aspects of Intel's operations worldwide. The C&NR SCS formalizes Intel's approach to the implementation of source reduction measures for new processes. The SCS is expected to drive the management process to ensure that the future processes and factories are designed which optimize environmental performance and meet Intel's needs for delivering leading edge technology development and manufacturing.

In addition, the C&NR SCS is responsible for all aspects of the environmental technology roadmaps which include air emissions, water and energy, as well as the SB 14 hazardous wastes. These roadmaps are reviewed by management regularly.

ADVANCED MICRO DEVICES, INCORPORATED (AMD)/SPANSION

AMD/Spansion assembled a Pollution Prevention Team to evaluate potential source reduction measures that would impact the major waste streams generated by its Submicron Development Center activities. A representative from each of AMD/Spansion's process modules comprised the Pollution Prevention Team, including a representative from the company's environmental, health and safety group who coordinated the team efforts.

SIPEX

Sipex has implemented a quality improvement system. Quality Improvement Meetings (QIM) provide a formalized structure and systematic process for department groups to identify and eliminate defects, which can include any process that wastes chemicals. QIM groups report their progress regularly to management and are recognized for completing a quality cycle, which involves identification, monitoring, analysis, and defect corrective action.

AGILENT TECHNOLOGIES

Agilent adopted its Environment and Sustainability Policy which required its managers and employees to act in an environmentally responsible manner in regard to its operations, products, and services. Agilent developed courses of actions to comply with this policy, including conducting operations that are committed to pollution prevention. Agilent formed a Source Reduction Committee comprising its environmental health and safety staff, who presides at regular meetings, the engineering manager who provides source reduction information and updates, and the safety representative for safety consultation and reporting.

ANALOG DEVICES, INCORPORATED

Analog Devices, Incorporated (ADI) management has been committed to promote environmental consciousness in its business operations. ADI's Sunnyvale facility has been certified to be ISO 14001 compliant. Hazardous waste source reduction is one of the main elements of its Environmental Management System (EMS). Management regularly reviews source reduction measures to ensure that its EMS is effective and to get feedback on future efforts.

MICREL SEMICONDUCTOR

Micrel's Wafer Fab Operations facility achieved ISO 14001: 1916 certification in 2004. Micrel's environmental policy is to: meet or exceed applicable environmental, legal and other requirements, health and safety laws, regulations and company standards; continuously improve its environmental management system, leading to ISO 14001; prevent pollution by reuse, recycling and the pursuit of reductions in waste, emissions and energy use; continuously improve performance with respect to objectives and targets set within the framework of its environmental system; and include environmental health and safety considerations in the design of its products and in the conduct of its business.

VII. SOURCE REDUCTION ACTIVITIES

The discussion below is a summary of source reduction measures implemented, or planned to be implemented, by semiconductor companies. Furthermore, profiles of selected companies, which include a discussion of source reduction activities implemented by the company, are presented in Section VIII.

1. Wastewater

For the purpose of this report, wastewater would include all waste streams that were treated at the facility's wastewater treatment system and discharged to a publicly owned treatment works (POTW). This wastewater may have originated from the wet etching process where baths are regularly changed, miscellaneous wafer and tools cleaning processes at various stages of wafer fabrication, and scrubbers where corrosive gases and vapors generated from several manufacturing operations are removed. The semiconductor industry generates a large amount of wastewater for cleaning to ensure that the wafer be free of contamination. There are several water baths and rinsing operations at various stages of the wafer fabrication process.

A common source reduction measure implemented by several facilities to reduce wastewater is the installation of recirculation filters in cleaning and etching baths, such as the BOE and sulfuric acid baths. This recirculation filter system removes particulates and other contaminants from the baths while they are in operation. This allowed facilities to extend the bath life, and thus, reduced bath change out frequency. Some facilities previously changed their baths on a regularly scheduled time period, such as every shift. Facilities modified this practice, and instead, now conducted bath changes based on the number of wafers processed.

Facilities also reported increased use of dry etch tools. Wet etch processes are significant contributors to wastewater, both from hazardous materials used, and from rinse water. Use of dry plasma etch eliminates the use of aqueous hazardous materials for etch, and the use of deionized water for rinse.

Facilities also replaced older process with newer tools that generate less wastes. Advanced Micro Devices (AMD) (recently named Spansion) installed a more efficient spray tool to replace a wet sink for removing oxide from the wafer during pre-diffusion cleans. The spray tool applied chemicals more efficiently than a wet sink chemical immersion bath, resulting in significant reduction in chemical consumption. Spectrolab replaced its older process benches with new benches that have automatic shut-off systems that prevent constant process wastewater overflow.

Silicon wafer production has numerous steps that require a large amount of corrosive aqueous chemicals and rinse water. Spectrolab switched to gallium arsenide wafers because the production of gallium arsenide wafer solar cells does not require the steps required for silicon wafers thereby reducing the use of aqueous chemicals and rinse water. Spectrolab secured a 47 percent reduction in waste generation because of this transition. Also, Spectrolab further reduced rinse water generation by working with their supplier to have the supplier deliver a substrate that does not need further cleaning.

A couple of facilities reported that there were occasions when excess water was entering the acid waste collection system, resulting in an increased volume of hazardous wastewater. Sources of unnecessary excess water were process tools that had water trickle purges that were not necessary, and some tools that had diversion valves left in the improper position after maintenance activities. Piping leaks also contributed to the wastewater volume. When these sources were identified and corrected, facilities significantly reduced wastewater volume.

AMD/Spansion reduced its slurry dispense rate for polish and pad conditioning by 50 percent without affecting product quality. This reduced its wastewater generation by 110,000 pounds. AMD/Spansion also installed a spray tool to replace a wet sink for removing oxide from the wafer during the RCA pre-diffusion clean process. The spray tool applies chemicals more efficiently than a wet sink chemical immersion bath.

AMD/Spansion achieved additional reduction of its wastewater when it modified its filter clean procedures. Before, operators would disable the system, depressurize the cylinder, and drain the fresh slurry inside the cylinder to the neutralization system before removing the filter bag. Each filter change resulted in about four gallons of unused slurry drained to the neutralization system. The modified procedure requires that the slurry distribution unit pump the slurry out of the filter housing prior to shutting the unit down for filter replacement.

Some facilities reclaimed its process wastewater for reuse as make-up in cooling towers and scrubbers. Vitesse Semiconductor installed ion exchange columns to remove fluoride ions from the second and third dump rinse that had lower concentration of fluoride ions than the first rinse. The reclaimed waster was then reused in the cooling towers, fume scrubbers, and the reverse osmosis system. Jazz Semiconductor also reported reusing 15 percent of its treated wastewater in its wet scrubbers.

2. Solvents

Solvents are commonly used during semiconductor fabrication to clean equipment and parts. Photoresist waste from the photolithography process also contributes to the total solvent wastes.

The use of negative photoresist requires xylene and n-butylacetate, isopropyl alcohol (IPA) rinses, and other clean-up solvents. The positive photoresist process uses less hazardous acetone for rinsing and cleanup, while the developing process uses aqueous materials. Several semiconductor companies have switched to positive photoresist which requires less chemical usage and results in less generated hazardous waste.

AMD/Spansion reduced its cups cleaning frequency from once per shift to once per month. This was made possible when AMD/Spansion installed an automated cup cleaning system on its photolithography process track. This enabled the litho cups to be cleaned continuously in place. Previously, the cups were removed each shift and cleaned in the solvent sink. Continuous cleaning of cups removes the resist residues before hardening, thereby decreasing the amount of solvent needed to clean the cups. Estimated reduction was 9,800 pounds of mixed solvent waste.

AMD/Spansion modified its coating recipe, and reduced mixed solvent waste by 6,700 pounds/year. The coating recipe calls for pre-wetting the wafer with a resist base solvent prior to the applying resist, enabling the resist to spread easier over the wafer. This will then require less resist to coat the wafer.

Several facilities simply extended the number of lots that could be run through a solvent bath before it is changed. Extending the service life reduced solvent waste by as much as 45 percent.

Companies also looked at minimizing photoresist consumption, largely because photoresist is an expensive item. Photoresist is applied to a wafer by spin coating. The wafer is held on a turntable where a measured amount of chemical is dispensed on to it from a nozzle. Initially, the wafer may or may not be spinning. Once the chemical is dispensed, the spin speed is increased to spread the chemical over the surface. The thickness and uniformity of the photoresist layer is critical to the success of the pattern transfer. Several facilities had optimized their spin coating process, such as Analog Devices which installed more precise photoresist dispense pumps. These newer pumps had a lower variation than the older pumps, and this allowed for better dispense control and less over-application to ensure adequate coating. Intel also recognized the source reduction opportunity in optimizing the spin coating process and reduced the overspray on the equipment, and was able to decrease photoresist waste generation by about 75 percent. Vitesse also reported optimizing the spin rate and reduced the overspray resulting in a reduction of solvent needed for cleaning the equipment. Agilent, instead of pouring photoresist out of bottles, used jet pipettes and further reduced the photoresist quantity wasted.

Hexamethyldisilane (HMDS) is typically used as an initial coating on the wafer's oxide surface to increase the adhesion of photoresist. It is typically applied by dripping the chemical on while the wafer is still spinning. The majority of the chemical is spun off the wafer surface and results in waste. A process known as vapor prime reduces the amount of HMDS input and waste generated. In this process, wafers are put into a vacuum oven in which the HMDS is applied in vapor form. With this process, it was estimated that HMDS is used with a >95 percent efficiency when compared with the drip process.

Vitesse Semiconductor designed an automatic photoresist dispensing unit instead of manual dispensing. Previously, operators would manually replace the photoresist bottles before they are completely empty so as not to interrupt the dispensing process. This resulted in wasted unused photoresist. The automatic dispensing system reduced the generation of wasted residual photoresist remaining in the container.

Several semiconductor manufacturing processes involve the use of vacuum equipment which necessitates regular oil changes. To reduce generated oil wastes, some semiconductor companies used dry pumps to meet their vacuum needs.

Acetone and isopropyl alcohol are commonly used in cleaning and drying activities. On some wipe-down operations, deionized water had replaced the use of acetone and IPA. The disadvantage of using water or water/solvent mixtures instead of pure solvent is that the water evaporates more slowly and thus, takes longer to dry. However, one facility felt that the reduction in solvent usage outweighs this disadvantage. Another facility reduced its IPA usage by using spin drying for certain components instead of using alcohol as a drying agent.

Intel further reduced its solvent waste when it used aqueous slurry blast cleaning instead of solvent cleaning of dry etch tools. This process uses a self-contained system which uses a slurry of very fine alumina grit and water. The system operates in a closed loop and is free of dust and chemicals. Slurry is directed through a special high volume vortex pump and through an abrasion resistant hose to the blast gun where regulated air pressure can be added to increase the level of process aggressiveness.

NEC Electronics America (NECELAM) eliminated about one million pounds of solvent-contaminated condensate water when it installed a thermal oxidation unit to destroy organic vapors from its fabrication process air exhaust. The organic solvent-contaminated air was previously sent to a carbon-based absorption unit. The hazardous condensate, consisted of water and organic solvents including methyl ethyl ketone, was generated when the carbon material was steam-stripped to regenerate the carbon. The exhaust, which is contaminated with organic solvents, has since been re-routed to a thermal oxidation unit, which destroys exhaust organic vapors.

Collected solvent waste streams may contain unnecessary water that contributes to the volume of the waste stream. Intel and Analog Devices investigated and audited the process tools to identify unwanted water sources. Intel achieved a 40 percent reduction after implementing the audit-based measures.

During mesa etch, Microsemi previously applied a wax coating onto one side of the wafers as masking. This wax was then removed in a degreaser. Microsemi determined that this wax can be replaced with a polyethylene tape that can easily be removed with alcohol, thus eliminating the need for degreasing.

Shell Solar Industries cut its waste oil generation by about 90 percent when it reused its used cutting oil. The cutting oil waste was generated from silicon ingot cutting operation that uses an abrasive slurry consisting of oil and silicon carbide. Reclamation involves sending the spent slurry to a centrifuge to separate carbide and silicone grit from the oil, which is then redistilled and reused until spent.

Instead of collecting all solvent waste streams together, several semiconductor facilities installed multiple waste collection systems to enable some select waste streams to be sent to an off-site recycler.

3. Corrosive Liquids

For the purpose of this report, this waste stream refers to various acidic or caustic wastes that were shipped off site, rather than directed to the facility's wastewater treatment system. This corrosive liquid waste stream was generated from various cleaning and etching operations.

As discussed in the wastewater section, facilities modified their bath changeout schedule to reduce wastewater. Doing bath changeouts based on the number of wafers processed instead of a fixed time schedule also reduced their corrosive wastes. Furthermore, recirculating the BOE, consisting of hydrofluoric acid and ammonium fluoride, through filters to remove particulates and other contaminants extended the bath life, reducing BOE wastes.

For years, Microsemi had treated the small silver end caps and other silver components with potassium cyanide etching solution to remove any possible surface irregularities. Microsemi worked with the vendor, and required the vendor to supply the caps clean and ready to be used. Since Microsemi no longer needs additional etching, the cyanide waste from end caps etching was eliminated.

Fairchild Imaging diluted its hydrofluoric acid concentrations in two operations: one from 4:1 to 6:1, and the other from 45:1 to 50:1. This change in concentration reduced the amount of hydrofluoric acid being used, with no adverse impact on product quality. Fairchild also replaced an ammonium fluoride/hydrofluoric/acetic acid mixture with an "all-dry" single-step operation using a reactive ion etcher for all production parts.

In 2003, AMD/Spansion replaced an older polisher with a new polisher tool. The new polisher uses a commercially available slurry, which contains a lower percentage of metal oxide, and more than 97 percent DI water. The new polisher also uses more effective polish pads and does not require a carrier film. The pad life is expected to increase almost three-fold, and pad waste volume should decrease by about 50 percent.

4. Contaminated Debris

This waste stream consisted of various debris that were contaminated with either solvents or corrosives, and included wipes, solvent bottles, and personal protective equipment.

Analog Devices' employee-based quality improvement team identified the elimination of grease pens used to mark diffusion furnace data as a source reduction opportunity. Before, cards marked with grease pens were being cleaned off with isopropyl alcohol daily with wipes which were then disposed as hazardous wastes. With the use of the recommended water-soluble pens, the wipes were classified as non-hazardous.

Polish pads are one of the contaminated debris generated by AMD/Spansion. To reduce polish pad wastes, AMD/Spansion replaced the original test wafer method for qualifying the polish process with the pilot wafer method. The pilot wafer method enabled a process to be qualified using product wafers instead of oxide test wafers. Using product wafers during qualification saved processing time and polisher downtime to verify polish process control and eliminated the need for test wafers. Additionally, this approach increased polish pad life by about 55 percent as well.

5. Others

Pyrophoric wastes were generated at Agilent's vapor phase epitaxy (VPE) reactors where phosphorous was used. Agilent replaced its VPE reactors with EMCORE reactors and Aixtron reactors. EMCORE and Aixtron reactors do not generate pyrophoric wastes. These reactors are nitride reactors and do not use phosphorous that would cause wastes to be pyrophoric.

Intel reduced about 10,000 pounds/year of the carbon exchanger resin in the C4 process when it eliminated the use of carbon resins which were found to have no effect on the effectiveness of the zeolite process. Before, it was believed that total organic compounds (TOC) reduce the lifetime/effectiveness of the zeolite bottles which are used to reduce the amount of lead in the throughput. To prevent TOCs from getting into the zeolite bottles, the carbon bottles were put in series ahead of the zeolite bottles. However, studies showed that even without the carbon resins, the effectiveness of the zeolite bottles was not impacted.

PROPOSED SOURCE REDUCTION MEASURES

This section discusses the measures that were reported by facilities as the ones that they would implement according to their 2002 SB 14 Plans. Some facilities proposed measures that have already been implemented by other facilities, including:

- Increase use of dry etch tools.
- Optimize control of photoresist head.
- Install lower volume pumps.
- Minimize water contamination of solvent and acid wastes.
- Segregate n-Methyl-Pyrrolidinone (NMP) and other photoresist strippers for recycling.
- Install auto dispense system in sulfuric cleaning sink.
- Install chemical sensors in diffusion tube cleaner acid bath.

1. Wastewater

Analog Devices, Incorporated (ADI) will be evaluating the use of ozone generators to replace liquid hydrogen peroxide in the sulfuric acid cleaning baths as an oxidizer. Ozone is created from ambient air oxygen inside the ozone generator and is then pumped into the process bath. This would completely replace all hydrogen peroxide used in the process. ADI recognized that this is a complex alternative, and expects to take some time to complete the evaluation. While the ozone generator system is being evaluated, ADI will also be looking at automating the addition of hydrogen peroxide to the sulfuric acid baths. Currently, hydrogen peroxide is manually added on a regular basis to maintain the required oxidizing potential; however, this method lacks both precision and control. Using the auto dispense system, hydrogen peroxide will be dispensed at pre-determined frequencies.

Some processes involve tools that are enclosed and various acids are sprayed on to the wafer surface rather than dipped into a liquid bath. Newer spray nozzles for these tools had been identified as being more efficient and thus reducing chemical consumption.

ADI will also be looking at installing a bulk dispense system for its photoresist developer. Currently, the developer is stored in 1-gallon bottles and is manually poured into the process tools. These bottles are not always completely emptied. The bottles are cleaned prior to disposal. Using the bulk dispense system, chemical will be stored in a 55-gallon drum, thus eliminating the cleaning of bottles. ADI will also use the bulk dispense system for its sulfuric acid system.

Novellus Systems is considering diverting non-hazardous deionized rinse water and reduce the wastewater volume going to treatment. They intend to accomplish this diversion by modifying waste plumbing, installing automated controls, monitoring real time flow, and monitoring for copper and pH. Novellus plans on recycling treated water back to the plant for non-process use to reduce city water consumption. They recognized that this does not address hazardous waste source reduction, but it yields overall cost savings and significant reduction in waste discharge.

AMD/Spansion plans on reconfiguring the waste collection process to separate the rinse waste from one of its tools from the copper plating bath waste from its electroplating process. Segregation will be based on real-time analysis through the integration of logic-based monitor and control system with real time feedback using an in-line analyzer. Non-contact process water will potentially be reused in the tools with rinse water diverted to industrial wastewater treatment.

PerkinElmer proposed to re-route deionized/reverse osmosis brines and eliminate this stream from going through its acidic wastewater neutralization system (AWNS), thus reducing the volume of hazardous wastewater being treated at the AWNS. The DI/RO brines contain elevated levels of calcium and magnesium carbonate brines, and can be discharged directly into the sanitary sewer, bypassing the AWNS. Elimination of this stream from AWNS would also aid system performance by increasing residence time for those liquids that require treatment.

2. Solvent

Jazz Semiconductor is looking at replacing glass chemical bottles in its photoresist delivery system with the NowPack smart probe system. Jazz reported that this is a delivery system designed to optimize the delivery of photoresist. Use of the NowPack systems, as reported, would allow for almost 100 percent of the photoresist to be applied to the wafer versus 80 to 85 percent removal efficiency for the glass containers. With the glass containers, the left over resist needs to be disposed as spent solvent and the glass container is disposed as hazardous waste. Conversely, the plastic bag in the NowPack system will be bulked with other solvent contaminated debris and sent to a permitted treatment, storage, and disposal (TSD) facility for fuels blending. The outer plastic container would be disposed of in a plastic recycling program.

VIII. COMPANY PROFILES

Profiles of selected companies are included in this report to show what these companies have done to reduce their wastes. Presented in these profiles are wastes generated by each company, factors that affected waste generation (such as increase or decrease in production), and the company's source reduction activities.

ADVANCED MICRO DEVICES, INCORPORATED (AMD)
SPANSION LLC
Sunnyvale, California

A. Company Background

Advanced Micro Devices, Incorporated (AMD)/Spansion is a supplier of integrated circuits for personal and networked computing and communications. AMD provides Windows compatible processors, flash memory devices, and communications and networking products that enhance the power and utility of PC's as information-processing and communication tools.

AMD's Sunnyvale, California facility began its Submicron Development Center (SDC) manufacturing operations in 1990. Prior to SDC, AMD operated integrated circuit fabrication facilities at other locations within the Santa Clara County, which have since been closed. In July 2003, a new flash memory semiconductor joint venture, Spansion LLC, was formed by the integration of AMD's and Fujitsu Limited's flash memory businesses. Ownership and operations of the SDC site were transferred to Spansion LLC as part of this joint venture. Spansion LLC is a supplier of flash memory products under the Spansion™ brand.

In the Sunnyvale facility, AMD/Spansion conducts research and development for manufacturing processes and semiconductor products. As of 2004, the AMD/Spansion site employs approximately 1,700 people.

B. Major Wastes Generated

WASTES	CWC	1994 WEIGHT, POUNDS	1998 WEIGHT, POUNDS	2002 WEIGHT, POUNDS	WASTE DESCRIPTION
Category A					
Wastewater	134	1,006,000,000	755,987,723	894,320,968	
Category B					
Mixed Solvents	214	138,178	45,261	17,650	Generated from photolithography process
Copper Sulfate Solution	132	---	21,812	64,064	Plating bath waste and rinse solution
Acid Contaminated Debris	181	13,140	11,692	7,641	Wipes contaminated with corrosive materials
Solvent Contaminated Debris	352	23,630	9,307	6,310	Wipes, resist bottle liners, contaminated packaging, parts from process tool maintenance
IPA	135	9,369	8,409	---	Generated from vapor dryers
TOTAL Category B Wastes		**184,317**	**96,481**	**95,665**	

--- No data available. Waste was either not generated or not a major waste stream on the indicated reporting year.

C. Factors Affecting Waste Generation

AMD/Spansion uses the number of wafer activities when normalizing waste generation. From 1994 to 1998, two primary process developments influenced waste generation: increased wafer size and increased circuit complexity. The increase in wafers size and the increase in the number of metal layers deposited on the wafer resulted in a corresponding increase in chemical usage. Factoring in the wafer size and metal layers in the manufacturing activity, there was about 40 percent increase in 1998 manufacturing activities when compared with 1994.

In 2002, AMDSpansion's total wafer activities decreased by 33 percent versus its 1998 wafer activities. Also, a second plater that generated copper sulfate electroplating waste was installed in 2001. This new process was the primary reason for the three-fold increase in copper sulfate waste.

D. Source Reduction Activities

In 1998, AMD/Spansion reduced its Category B waste generation by about 112,000 pounds. When normalized, this represents a 60 percent reduction as compared with 1994 quantities. In 2002, each of the major waste streams was reduced except for copper sulfate wastes. This increase in copper sulfate wastes resulted in an increase in overall waste generation when normalized for manufacturing activities. Although total waste in 2002 was lower than the 1998 total wastes, when normalized, 2002 waste per manufacturing activity increased by about 50 percent.

1. Mixed Solvents (CWC 214)

AMD's reduction of its mixed solvent waste contributed mostly to the company's overall waste reduction progress. From 1994 to 1998, there was an overall reduction of about 93,000 pounds (67 percent reduction). In 2002, mixed solvent waste was reduced by about 27,000 pounds, or over 60 percent reduction when compared with 1998 quantities.

Measures implemented included:

- *Installed automatic in-place cup wash instead of solvent cup cleaning*

AMD installed an automated cup cleaning system into a photolithography process track. This system enabled litho cups to be cleaned continuously in place. Before, cups were removed every shift and cleaned in the solvent sink. With the continuous automated cup cleaning system, resist residues are removed before hardening, and hence, requires less solvent to clean the cups. Estimated reduction due to this activity was 9,800 pounds of mixed solvent waste annually.

- *Extended cup cleaning from daily to monthly*

Before implementation of the automated cup washes, operators cleaned the cups from the photolithography tracks in the solvent sink after each shift. AMD changed the manual cleaning frequency to once per month. This resulted in an estimated annual reduction of 13, 900 pounds of mixed solvent.

- *Modified coating recipe*

The coating recipe was changed by adding a solvent dispense step prior to the resist dispense. This solvent pre-dispense step pre-wets the wafer surface to enable the resist to spread more easily over the wafer, thereby requiring less resist to coat the wafer. This recipe modification was qualified on the tracks in early 2000, and AMD reported an actual reduction of about 6,700 pounds/year on this approach.

To further reduce solvent wastes, AMD/Spansion is optimizing dummy dispense. Resist is dispensed into the resist nozzle block once each hour on several tracks. This dummy dispense will be reduced to one at each lot head instead of every hour. This will reduce the total quantity of resist consumed. AMD/Spansion is also evaluating a wafer coating technique that pre-wets the wafer with a resist base solvent prior to applying the resist chemistry. The new resist will replace two resist chemistries and developer. In addition to reducing the resist usage, the new resist chemistry will eliminate the need for a developer. The facility estimated an annual reduction of 5,000 pounds of solvents.

2. Wastewater (CWC 134)

- *Reduced slurry flow rate during polish and pad conditioning*

AMD reduced the slurry dispense rate for each polisher by 50 percent without affecting product quality. Estimated reduction was 110,000 pounds annually.

- *Replaced wet sink with spray tool for pre-diffusion cleans*

A wet sink was replaced with a spray tool for removing oxide from the wafer during the RCA pre-diffusion clean process. The spray tool applies clean chemicals more efficiently than a wet sink chemical immersion bath. AMD studies showed the following reductions: 85 percent ammonium hydroxide, 72 percent hydrogen peroxide, and 67 percent hydrochloric acid.

- *Modified filter clean procedure*

Polish slurry is filtered and pumped to the chemical mechanical polishing (CMP) tools. The filter bag is removed and cleaned twice a week. The previous filter cleaning procedure required disabling the system, depressurizing the cylinder, and draining the fresh slurry inside the cylinder to the neutralization system before removing the filter bag. Each filter change resulted in four gallons of unused slurry drained to the neutralization system.

The modified filter cleaning procedure requires that the slurry distribution unit pump slurry out of the filter housing prior to shutting the unit down to replace the filter. This avoids the unnecessary waste of unused slurry.

Furthermore, AMD/Spansion will look at segregating rinse water from copper plating bath waste. One of AMD/Spansion's plating lines produces a rinse waste, and its copper electroplating process produces a hazardous plating bath waste. The current configuration of the waste collection system results in combining the plating rinse water with the copper plating bath waste. AMD/Spansion plans on reconfiguring the waste collection setup to separate the rinse waste from the copper plating bath waste. Segregation will be based on real-time analysis through the integration of a logic-based monitor and control system with real-time feedback using an in-line analyzer. The volume of copper plating waste disposed off-site will decrease as the rinse water would not contribute to the copper waste stream volume. Non-contact process water will potentially be reused in the tools and rinse water diverted to industrial wastewater treatment.

3. Solvent Debris (CWC 352)

To reduce solvent waste and debris, AMD/Spansion will be sending litho cups off-site for cleaning. Currently, litho track cups are cleaned in the solvent sink where the cups are soaked in acetone to remove hardened resist. Solvent baths are drained to the mixed solvent collection system and refilled with three gallons of acetone twice per week. By sending the cups off-site for cleaning, this process is eliminated, and solvent waste and debris should be reduced by about 8,000 pounds and 100 pounds per year, respectively.

4. Corrosive Debris (CWC 181)

- *Installed polish slurry mixer*

Custom polish slurry mixes are prepared in-house. In 1995, AMD replaced its manual mixing carts with a slurry mixer to improve the handling and mixing of polish slurries. It reduced the wipes and debris generated from cleaning when using the carts to manually mix slurry.

- *Extended polish pad life*

Used polish pads are disposed as corrosive debris. AMD evaluated its process to increase the number of wafers polished per pad. The pilot wafer method replaced the original test wafer method for qualifying the polish process. The pilot wafer method enabled a process to be qualified using product wafers instead of oxide test wafers. Using product wafers during qualification saved processing time (and polisher downtime) to verify polish process control and eliminated the need for test wafers. The polish pad life was increased by 55 percent. Estimated reduction was 940 pounds per year.

- *Employee Training*

Several employee awareness measures were implemented to improve employees' segregation of non-contaminated debris from acid and solvent wastes. AMD/Spansion incorporated in its operations a self-inspection procedure for tool preventive maintenance tracking program; an inspection checklist to inspect module debris cans weekly; and, have a waste segregation segment as part of its annual training program. Contaminated debris waste was reduced by about 35 percent in 2002 compared with 1998, although the direct effect of improved awareness efforts on hazardous waste source reduction was unknown.

In 2003, AMD/Spansion replaced an older polisher with a new polisher tool. The new polisher uses commercially available slurry, which contains a lower percentage of metal oxide, and more than 97 percent DI water. The new polisher also uses more effective polish pads and does not require a carrier film. The pad life is expected to increase almost three-fold, and pad waste volume should decrease by about 50 percent. Also, AMD/Spansion will conduct further evaluation of its polish pads to determine if they are properly classified as hazardous wastes. If the polish pads can be classified as non-hazardous wastes, a reduction in acid debris would be realized.

AMD/Spansion also employed the services of a chemical broker for its unused or obsolete materials resulting from manufacturing process changes. These materials include photoresists, slurry solutions, buffered oxide etches, acids, hydroxides, and solvent-based copier toners. AMD/Spansion usually works with its chemical suppliers to return as much unused chemical as possible. But in the event that the suppliers are unable to take back a product, AMD/Spansion would use the broker. The broker specializes in locating chemical end users for unwanted chemical products. The materials are then reused for their originally intended purpose or as an effective substitute for commercially available product.

Another AMD/Spansion source reduction project was the ozonated deionized (DI) water resist stripping project. Partially funded by International Sematech (a consortium of semiconductor companies), an ozone generator was installed on an existing spray tool used for pre-diffusion wafer cleans in 1999. Deionized water saturated with ozone can replace traditional acid wet strip recipes in resist strip and clean applications. These strip and clean chemistries are water intensive due to rinse steps between each chemical cleaning and water rinsing required to remove sulfur residues. By eliminating some of these rinse steps, the overall processing time was expected to be reduced.

Results of this project showed that although the technology is effective, the ozonated DI water resist strip process is slower and less uniform than the standard sulfuric acid, hydrogen peroxide mixture (SPM) process. AMD/Spansion concluded that further work is required before advancing to production.

AGILENT TECHNOLOGIES
SEMICONDUCTOR PRODUCTS GROUP
LUMILEDS LIGHTING
San Jose, California

A. Company Background

In November 1999, Hewlett-Packard Company split its non-PC business into a new company, Agilent Technologies. Agilent facilities included three manufacturing divisions. These divisions were located in San Jose, Santa Clara, and Newark. These facilities specialized in light emitting diodes (LED)-based optoelectronics products, microwave components, and high-speed silicon integrated circuits. The San Jose facility started operation in 1985, and the Santa Clara and Newark sites in 1991.

The same day that Agilent Technologies was formed due to the split off from the Hewlett-Packard Company, the Optoelectronics division, located at the San Jose site, became Lumileds Lighting, a joint venture between Agilent Technologies and Philips. Lumileds remains at the San Jose site as an independent business, with facilities and environmental health & safety (EHS) support from Agilent personnel, under contract.

In 2001 and 2002, Agilent's other manufacturing operations in Santa Clara and Newark facilities moved out of state.

B. Major Wastes Generated

Note: Even though Lumileds has a separate U.S. EPA ID from Agilent San Jose facility, the wastes reported in this profile under the San Jose site reflects the total of Agilent's and Lumileds' wastes so as to have continuous data comparability over time.

San Jose Site

WASTES	CWC	1994 WEIGHT, POUNDS	1998 WEIGHT, POUNDS	2002 WEIGHT, POUNDS	WASTE DESCRIPTION
Category A					
Wastewater	135	711,000,000	789,000,000	390,000,000	From wafer rinsing operations, wet scrubbing
Category B					
Waste Solvents	791	200,580	206,824	135,820	From equipment cleaning
Baghouse filters, etc.	181	16,940	31,582	31,385	From preventive maintenance
Sludge	171	218,420	146,060	148,000	From wastewater treatment plant
Subtotal (Category B)		435,940	384,466	315,205	
Extremely Hazardous					
Pyrophoric solids	181	---	4,452	1,855	From VPE process
Pyrophoric Slurry	181	960	3,864	1,390	From VPE process
Pyrophoric Oil	791	200	2,929	953	From various pumps
Subtotal EH wastes		1,160	11.245	4,198	
TOTAL Wastes (A+B+ EH)		**711,437,100**	**789,395,711**	**390,319,403**	

C. Factors Affecting Waste Generation

There was no production increase or decrease reported.

D. Source Reduction Activities

1. Waste Solvents (CWC 791)

This waste stream was generated from cleaning equipment, parts, and wafers in a variety of processes.

Negative photoresist, which require solvents for cleaning, are being phased out in favor of positive photoresist.

2. Baghouse Wastes

This waste was generated from periodic filter changes as required by the preventative maintenance process.

- *Improved operating procedures*

Liquid is drained from the ductwork prior to the baghouse, reducing the frequency of filter replacement by about 20 percent.

- *Installed a new pump and abatement system*

The BOC Edwards is a wet scrubbing abatement tool that is being evaluated on a couple of the OMVPE reactors. These reactors normally vent to an oxidation burner and then to the baghouse. The BOC Edwards system transfers the process waste from a dry solid into an aqueous stream from which the waste is subsequently precipitated out in the onsite wastewater treatment facility. This system has not been particularly reliable to date.

3. Pyrophoric Solids

These are solid wastes, such as wipes, gloves, and other miscellaneous items, that were contaminated with phosphorous-containing residue. These are collected separately from other hazardous wastes due to their pyrophoric classification (ability to spontaneously ignite).

- *Vapor Phase Epitaxy (VPE) reactors replaced*

Agilent replaced its VPE reactors with EMCORE reactors and additionally installed three Aixtron reactors. These are nitride reactors that do not use phosphorous and therefore do not generate any pyrophoric waste.

- *Filters pre-coated with lime*

Lime acts as a buffer preventing the phosphoric acid from quickly destroying the filters. The lifespan of the filters is longer by about double (from three weeks to six); however, this does not take into account the overall increase in production and chemical throughput. The actual lifespan is better than the 200 percent derived from these figures.

4. Pyrophoric Slurry

Arsenic and phosphoric solids that were collected from the sinks, bubblers, and other manufacturing processes are immersed in ethylene glycol and turned into slurry to ensure safe transport to the disposal site.

Agilent Santa Clara Site

WASTES	CWC	1994 WEIGHT, POUNDS	1998 WEIGHT, POUNDS	2002 WEIGHT, POUNDS	WASTE DESCRIPTION
Category A					
Wastewater	135	74,200,000	73,000,000	61,000,000	From wafer rinsing operations, wet scrubbing
Category B					
Waste Solvents	741	115,800	28,712	27,776	
Arsenic Sludge	181	1,500	4,595	3,095	
Solvent-contaminated Debris	352	8,460	3,120	1,430	

C. Factors Affecting Waste Generation

There was no production increase or decrease reported.

D. Source Reduction Measures Implemented

Even though Agilent's facilities in Santa Clara and Newark were already closed in 2002, this profile includes the measures implemented by these facilities before they shut down their operations.

1. Wastewater

Wastewater is generated in the wafer cleaning process, by the generation of DI water, and from air abatement scrubbers.

- *New grinding process*

In 2000, a new grinding process was implemented that eliminated the generation of the aluminum oxide slurry and reduced the amount of wastewater generated. The previous process to decrease the thickness of the wafers used an aqueous slurry compound with aluminum oxide as the primary cutting media. The spent slurry contains gallium arsenide and the resulting waste is hazardous as a federal Resource Conservation and Recovery Act (RCRA) D004 waste. The new grinder does not use consumable cutting media and therefore the resulting waste is smaller in volume. In addition, the water use with the grinder was reused several times prior to discharge – resulting in less generated wastewater.

2. Waste Solvents (CWC 741)

Waste solvents are generally spent organic solvents that were used to clean equipment, parts, and wafers in various semiconductor manufacturing processes.

- *Modified criteria for solvent bath change*

Instead of changing the solvent bath every shift change, Agilent based its changout time on the throughput (every 300 wafers).

- *Cleaning step eliminated*

The zero cleaning step was eliminated for 40 percent of the processed wafers. A zero cleaning step is used to start all wafers off at the same level of cleanliness. This is basically the initial cleaning of the wafers prior to processing. Agilent inspects received wafers and found that the cleanliness right out of the package was adequate for the most part.

- *Automation of process*

Agilent used jet pipettes instead of pouring out of bottles. This resulted in less resist waste and less waste bottles because of the shift to larger volume resist bottles (from 50 ml to 500 ml).

3. Solvent Contaminated Debris

This waste stream includes solvent-soaked wipes and other debris used to clean equipment.

- *Automation of process*

As mentioned above under waste solvents, Agilent used automated pipetting in the resist process, and this facilitated switching to larger volume chemical bottles. This reduced the waste bottle stream.

- *Segregation of wastes*

The facility implemented a better segregation of non-hazardous waste from the hazardous debris.

Agilent Newark Site

WASTES	CWC	1994 WEIGHT, POUNDS	1998 WEIGHT, POUNDS	2002 WEIGHT, POUNDS	WASTE DESCRIPTION
Category A					
Wastewater	135	165,000,000	270,000,000	366,000,000	From wafer rinsing operations, wet scrubbing
Category B					
Waste Solvents	741	56,940	74,718	86,173	

C. Factors Affecting Waste Generation

A new production FAB came on-line in 2000. The new manufacturing processes involved use of significant amount of solvent.

D. Source Reduction Measures Implemented

The plan to re-use water in scrubbers and plans to collect and reuse DI water from process rinsing operations in the DI water production system was not implemented due to plans to close the site.

To reduce solvent usage, Agilent modified two sinks to include smaller holding tanks. Although it might have reduced solvent usage, the total solvent waste generated in 2002 increased because of the new production fab that came online in 2000.

ANALOG DEVICES, INCORPORATED
Santa Clara, California

A. Company Background

Analog Devices, Incorporated (ADI) designs, manufactures, and markets a broad line of high-performance analog, mixed-signal and digital signal processing (DSP) integrated circuits (ICs) used in signal processing applications. ADI's products include analog-to-digital converters, amplifiers, power management devices, interface circuits, radio frequency (RF) ICs and DSPs.

The company is headquartered near Boston in Norwood, Massachusetts, and has manufacturing facilities in Massachusetts, California, North Carolina, Ireland, and the Philippines. It used to have two manufacturing operations in California located in Santa Clara and Sunnyvale. However, its Santa Clara site ceased manufacturing operations in July, 2003. ADI is an ISO 14001 certified facility.

B. Major Wastes Generated

Santa Clara Facility

WASTES	CWC	1994 WEIGHT, POUNDS	1998 WEIGHT, POUNDS	2002 WEIGHT, POUNDS	WASTE DESCRIPTION
Category A					
BOE	131	---	44,073	47,340	Used in cleaning baths
Hydrofluoric Acid	131	32,216	46,044	42,939	For etching
MF-319 Developer	123	---	110,238	86,269	Photoresist developer
Sulfuric Acid	791	129,971	268,185	245,415	Used for cleaning and stripping operations, and for acid waste neutralization and DI water production.
TOTAL Category A Wastes		**162,187**	**120,941**	**105,614**	
Category B					
Acid-Contaminated Gloves/Wipes	181	10,900	14,900	8,693	Generated from equipment wipe downs or spills.
EKC 265 Stripper	343	4,978	24,778	17,298	Used for stripping positive photoresist from wafers
EKC 922 Stripper	791	6,085	8,250	18,150	Used for stripping negative photoresist from wafers
Mixed Solvents	214	26,054	30,415	31,570	Consisted of waste negative photoresist developer and rinse solvent
Negative Photoresist	214	12,669	19,129	17,501	For masking
Positive Photoresist	214	16,545	15,899	8,672	For masking
Solvent-Contaminated Gloves/Wipes	352	6,150	7,570	3,730	Consisted of used gloves, contaminated plastics, and rags from equipment wipe down
TOTAL Category B Wastes		**83,381**	**120,941**	**105,614**	

--- No data available. Waste was either not generated or not a major waste stream on that reporting year.

C. Factors Affecting Waste Generation

Between 1994 and 1998, wafer fabrication activities decreased by 40 percent. The ADI Santa Clara facility did not have significant change in production rates for 1998 and 2002. The amount of wastes generated on those years should be very comparable.

Sunnyvale Facility

WASTES	CWC	1998 WEIGHT, POUNDS	2002 WEIGHT, POUNDS	WASTE DESCRIPTION
Category A				
Hydrogen Peroxide	135	25,085	50,624	For photoresist stripping
MF-319 Developer	123	69,856	132,322	Photoresist developer
Sulfuric Acid	791	85,200	96,345	Photoresist stripping and wafer cleaning
TOTAL Category A		**180,141**	**279,291**	
Category B				
EKC 265 Stripper		15,895	9,350	Photoresist stripping
Hydrofluoric Acid	131	169,811	178,059	Etching
Positive Photoresist	214	18,308	23,608	For masking
TOTAL Category B		**204,014**	**211,017**	

Note: The Sunnyvale facility started operations in 1995, and therefore there are no 1994 data.

C. Factors Affecting Waste Generation

ADI Sunnyvale measures its production output by the amount of six-inch silicon wafers completed, commonly referred to as “wafer outs.” In 2002, there was a 77.5 percent increase in wafer outs compared with 1998 wafer outs.

D. Source Reduction Activities

The ADI Santa Clara facility had an increased waste generation from 1994 to 1998. They attributed this increase to several market driven factors. ADI reported that the demand for newer and more sophisticated products with increasing complexities and cleanliness standards required ADI to use more chemicals in 1998 than in 1994. However, for the period 1998 and 2002, ADI had waste reduction of about 11 percent. This does not even include the significant reduction achieved on their calcium fluoride filter cake when they replaced their magnesium hydroxide/calcium chloride treatment system with a single calcium hydroxide treatment. Using this process, they were able to reduce their calcium fluoride filter cake by 63 percent.

As for ADI Sunnyvale facility, between 1998 and 2002, the normalized total waste generation decreased by about 27 percent if the 77.5 percent increase in production is factored in. If normalized for production increases, ADI would have had a total waste reduction of about 150,800 pounds. Total waste in 2002 had an actual increase of 29 percent.

Below are the source reduction measures implemented at the Santa Clara or Sunnyvale facilities.

1. Buffered Oxide Etch (CWC 131) and Hydrofluoric Acid Waste (CWC 131)

Buffered Oxide Etch (BOE) is used in baths located inside wet chemical benches. The BOE is recirculated through filters to remove particulates and other contaminants to extend bath life. The waste BOE is drained into a dedicated hydrofluoric acid waste drain that leads into the on-site Waste Hydrofluoric Acid Precipitation System.

- *Substituted treatment chemical*

Calcium fluoride was previously precipitated from the hydrofluoric acid-contaminated wastewater using magnesium hydroxide/calcium chloride treatment process. These two chemicals were replaced with calcium hydroxide, resulting in the reduction of filter cake volume, treatment costs, and labor costs. Although this did not reduce the BOE or hydrofluoric acid (HF) waste volume being generated, the change in chemical treatment system significantly reduced the filter cake manifested offsite from 129,420 pounds in 1998 down to 47,980 pounds in 2002 for a 63 percent reduction.

- *Improved process monitoring and maintenance*

At their Sunnyvale facility, ADI identified that there were occasions when excess water was entering the HF waste collection system which increased waste volume unnecessarily. ADI inspected each tool that discharges into the waste collection system. Some tools had unnecessary water trickle purges. Other tools had diversion valves that were left improperly positioned following maintenance activities. Also, piping leaks were identified and repaired.

The amount of HF waste generated in 2002 increased by only five percent, while production increased by 77.5 percent. If this production increase is used to normalize waste generation, 2002 waste volume would be about 123,000 pounds less than the 1998 waste volume.

2. MF-319 (CWC 123)

MF 319 is a photoresist developer that contains three percent tetramethyl ammonium hydroxide. It is discharged from the process tool into a dedicated acid waste drain line which flows into an on-site elementary acid waste neutralization system.

- *Used less MF-319 per wafer*

In July 1999, ADI's production quality improvement team found that ADI would be able to reduce the amount of MF-319 used per wafer without adverse impact to the product quality. ADI adjusted the dispense system to dispense the optimal amount of MF-319.

By implementing this process change, MF-319 usage in 2002 decreased by about 24,000 pounds, a 22 percent decrease from 1998 usage.

3. Sulfuric Acid (CWC 791)

- *Recirculated acid*

Sulfuric acid was recirculated and filtered to remove particles and other contaminants. This allowed ADI to adjust the change-out frequencies of their sulfuric acid baths thus extending the service life. This resulted in a reduction of about ten percent between 1998 and 2002.

4. EKC 265 Stripper (CWC 343)

- *Extended bath change-out frequencies*

As with adjustments made to extend sulfuric acid bath change-out frequencies, ADI implemented similar measures for their EKC 265 stripper baths. At their Santa Clara facility, ADI was able to reduce their EKC 265 wastes from 24,778 pounds generated in 1998 to 17, 298 pounds in 2002, while at their Sunnyvale facility, a reduction of 6,545 pounds was achieved even before factoring in the 77.5 percent wafer out increase in 2002.

5. Solvent Contaminated Gloves/Wipes (CWC 352)

- *Replaced grease pens with water-soluble markers*

ADI's employee-based quality improvement team identified elimination of grease pens that were used to mark diffusion furnace data as a means to reduce the number of wipes. Before, the cards marked with grease pens were being cleaned off with isopropyl alcohol each day and the wipes were disposed as hazardous waste. With the use of water-soluble pens, the wipes were made non-hazardous, thus reducing 3,480 pounds of hazardous waste.

6. Positive Photoresist (CWC 214)

- *Installed more precise dispense pumps*

ADI installed more precise dispense pumps that allowed for much better control of the amount of photoresist delivered to each wafer. The old pumps had a variation of 0.07 cc, while the new pumps had a variation of only 0.01 cc. This allowed for more precise dispense control, avoiding over- application while ensuring adequate wafer coating. ADI calculated an 8,784 pounds reduction in 2002 when normalized for the production increase compared with 1998.

D. Source Reduction Measures Proposed

ADI Santa Clara closed its semiconductor manufacturing operations in July 2003. The measures listed below were the ones proposed by ADI's Sunnyvale facility.

1. Hydrogen Peroxide (CWC 135)

- *Install ozone generator system*

ADI will be thoroughly evaluating ozone generators that will replace the need for using liquid hydrogen peroxide as an oxidizer in the sulfuric acid cleaning baths. This would eliminate 100 percent of the hydrogen peroxide used in the process. Ozone is created from ambient air oxygen inside the generator and is then pumped into the process bath. ADI recognized that this is a complex alternative, and expects to take some time to complete evaluation.

- *Install auto dispense system*

Currently, hydrogen peroxide is manually added to the sulfuric acid baths on a regular basis in order to maintain acceptable bath oxidizing potential. However, this method is not very precise or well controlled. An auto dispense system will be installed such that hydrogen peroxide is stored in a centralized tank and automatically dispensed at pre-determined frequencies. ADI projects that this measure could result in a 30 percent reduction in hydrogen peroxide use.

- *Change spray nozzles on spray acid tools*

Some processes currently in use at ADI involve enclosed tools using various acid sprays rather than dipping wafers into a liquid bath. Newer types of spray nozzles had been identified to be more efficient and ADI expected to use ten percent less chemical with the new spray nozzles.

2. MF-319 (CWC 123)

- *Install bulk dispense system*

Currently, MF-319 is stored in one-gallon bottles and are manually poured into the process tools. The bottles are not always completely emptied and anywhere between one to five percent of the chemical remains unused in the bottle. The bottles are cleaned to render them non-hazardous prior to disposal. ADI will look at a bulk dispense system that consists of an enclosed 55-gallon drum where the chemical is dispensed to the process tool. This approach would maintain better control of the exact amount delivered, leave less residual in the drum, and eliminate the cleaning and disposal of numerous 1-gal bottles.

3. Sulfuric Acid (CWC 791)

- *Install bulk dispense system*

The sulfuric acid and MF-319 are the two chemicals that are used most by ADI. As such, ADI is also planning to install a bulk dispense system for the sulfuric acid as discussed above for MF-319.

4. **Hydrofluoric Acid (CWC 131**)

- *Change spray nozzles on spray acid tools*

As discussed above in the hydrogen peroxide waste stream, retrofitting spray acid tools with more efficient spray nozzles could save ADI about ten percent less chemical usage.

- *Monitor HF collection system for water leaks*

Hydrofluoric acid waste is collected in a centralized tank for off-site treatment. The waste acid also includes all the contact rinse water as well as any water that has leaked into the system. These leaks would cause unnecessary amount of hazardous waste to be generated. The HF collection tank will be continuously monitored by ADI's Building Management System (BMS) so that if the liquid flow rate is greater than normal, the facility personnel will be notified for them to investigate. If the leak is identified and corrected quickly, the amount of waste can be greatly minimized. With the BMS system, ADI can also identify which tools were in operation or repaired at a given time.

- *On-site hydrofluoric acid treatment system*

Currently, waste hydrofluoric acid is collected in a centralized tank and then shipped off-site for treatment. The on-site treatment system will involve the use of calcium hydroxide to precipitate out the fluoride component. The treated water will be discharged to the local POTW.

5. Potentially All Waste Streams

- *Chemical Management Services (CMS)*

ADI will be evaluating whether it would be beneficial for them to hire a vendor that specializes in CMS. The vendor will be in charge of managing ADI's chemicals, gases, and wastes. The contract with the vendor has incentives for reducing chemical use and costs rather than the traditional vendor strategy of selling more to make more profit. Once the program is implemented, the selected vendor can use vendor expertise to work on many source reduction measures. In so doing they can actually profit from a share of the resulting cost reductions.

INTEL CORPORATION
Santa Clara, California

A. Company Background

Intel Corporation (Intel) is a manufacturer of high performance integrated circuits used in personal computers throughout the world. Intel's manufactured products include Pentium and Celeron microprocessors and flash memory chips. In addition to Intel's semiconductor manufacturing operations, a limited amount of research and development work focused on personal computers is conducted within the Santa Clara Operations.

Intel began its semiconductor manufacturing operations in July 1968 in Mountain View, California and currently operates three semiconductor manufacturing facilities in Silicon Valley which collectively are identified as Intel Santa Clara Operations. These operations are conducted at three campuses to include Mission, Bowers, and Walsh.

- Mission Campus (D2): The Mission Campus is the largest of the campuses within Intel's Santa Clara operations, and this campus began semiconductor manufacturing operations in 1989.

- Bowers Campus (SC1/SC2): Operations at the Bowers Campus include research and development, photomask production, and other operations-related support equipment.

- Walsh Campus: The Walsh Campus includes the small labs where analytical testing, limited assembly, and electrical testing of semiconductors and integrated circuits are performed.

B. Major Wastes Generated

Mission Campus

WASTE STREAM	CWC	1994 WEIGHT, POUNDS	1998 WEIGHT, POUNDS	2002 WEIGHT, POUNDS	WASTE DESCRIPTION
Category A Wastes					
NMD-W	135	---	99,130	553,192	Used in lithography as developer
NMD-3	135	---	1,093	510,408	Used in lithography as developer
96 percent Sulfuric Acid	135	403,880	310,380	492,000	Used in cleaning baths for cleaning of wafers between fabrication steps and for stripping photoresist
30 percent Hydrogen Peroxide	135	138,560	180,090	370,786	Mixed with other corrosives and used in the wafer cleaning process to facilitate removal of photoresist.
Megaposit MF-501 Dev	135	741,310	208,030	266,450	Used in lithography as developer
HF-containing waste Mixed Acid Precision Soln. Trimix BOE	 135 135 135	 0 57,360 28,060	 0 127,588 45,540	 1,244,070 81,540 69,920	Used in baths for wafer etching and cleaning operations
TOTAL Category A Wastes		**1,369,170**	**971,851**	**3,588,366**	
Category B Wastes					
Bulk Solvent	212	631,960	473,415	278,251	Made up of water, NMP, PRS 3000, isopropyl alcohol, ethanol, and methanol. Waste solvents generated from lithography and various cleaning operations
Ethylene Glycol	343	3,330	42,033	151,119	Used as cleaning solvent in various processes; also used in chillers.
Corrosive Solids Debris	181	23,250	51,729	69,888	Consists of rags and other solids that came in contact with corrosives, and exchange resins from water treatment process.
Photoresist Waste	214	175,810	42,210	39,264	Contains PBR-40 which is used to remove residual photoresist that builds up on the edge of wafers during photolithography process.
TOTAL Category B Wastes		**834,350**	**609,387**	**538,522**	
Extremely Hazardous Wastes					
Arsenic Wastewater	721	0	0	1,700	Generated from arsenic parts cleaning operations.
Hydrofluoric Acid Waste	792	---	1,030	400	Generated from the wet etch process.
Arsenic Debris	181	---	12,849	300	Consists of rags and other solids that came in contact with arsenic.
TOTAL Extremely Hazardous Waste			13,879	2,400	
TOTAL Wastes (Category A, B & EH)		**2,203,520**	**1,595,117**	**4,129,288**	

--- No data available. Waste was either not generated or not a major waste stream on that reporting year.

C. Factors Affecting Waste Generation

To manufacture new and improved products, Intel needed to make process and chemical changes that resulted in generation of more wastes. In the years from 1994 to 1998, Intel expanded rapidly. Its Mission Campus' D2 operation almost doubled in manufacturing size from approximately 38,000 to about 70,000 square feet. Expansion continued through 2002 where the D2 campus' manufacturing size grew to 147,000 square feet. With the increase in manufacturing size, there was an increase in production activities, which resulted in more chemical consumption and waste generation. However, when figures were normalized to account for increased production, it showed that Intel's source reduction activities were successful.

At the D2 campus, the increase in production is measured in terms of activities which represent a step in the wafer fabrication process. In 1998, there was a two and half-fold increase in production compared with 1994, i.e., the ratio of 1994 "wafer start" to 1998 "wafer start" is about 2.5. In 2002, "wafer start" increased 1.6 times as compared with 1998.

The quantity of wastes reported on the tables are actual weights, and do not reflect any normalization that would account for production increases.

Bowers Campus

WASTE STREAM	CWC	1994 WEIGHT, POUNDS	1998 WEIGHT, POUNDS	2002 WEIGHT, POUNDS	WASTE DESCRIPTION
Category A Wastes					
96 percent Sulfuric Acid	135	---	8,625	58,619	Used in cleaning baths for cleaning of wafers between fabrication steps and for stripping photoresist
30 percent Hydrogen Peroxide	135	9,310	11,849	12,580	Mixed with other corrosives and used in the wafer cleaning process to facilitate removal of photoresist.
29 percent Ammonium Hydroxide	135	9,500	15,461	10,563	Used in the wafer cleaning operations.
NMD-3	135	---	1,660	9,512	Used in lithography as developer
Cynateck PEH-1	135	690	1,455	4,883	
37 percent HCl	135	1,120	582	516	Used for pH control, ion exchange bed regeneration, and for removal of metal contamination in wafer fabrication.
TOTAL Category A Wastes		**20,620**	**39,632**	**96,673**	
Category B Wastes					
Hydrofluoric Acid Waste	791	81,480	137,392	23,458	Acid is used in baths for wafer etching and cleaning operations
Solvent, MEK	212	11,680	9,188	3,570	Consists of MEK, NMP, and IPA. MEk is used to strip off residual photoresist; IPA is used for wipe-downs and equipment cleaning
Solvent, Acetone, etc.	343	---	50	2,754	Consists of NMP, acetone, and IPA. Acetone is used for wipe-downs and equipment cleaning. Acetone is also used to facilitate flow of photoresist through dedicated piping.
Lab Pack	551	---	413	2,017	Consists mainly of expired and off-spec chemicals.
TOTAL Category B Waste		**93,160**	**137,855**	**31,799**	
TOTAL Wastes (Category A + B)					

--- No data available. Waste was either not generated or not a major waste stream on that reporting year.

C. Factors Affecting Waste Generation at the Bowers Campus

Production at this campus is measured in terms of photomask generation operations. Compared with 1994 production, 1998 production increased 2.7 times; while the 2002 to 1998 production ratio was 2.0. There was also a new mask design process that caused the increase in Category A wastes generation in 2002.

Walsh Campus

WASTE STREAM	CWC	1994 WEIGHT, POUNDS	1998 WEIGHT, POUNDS	2002 WEIGHT, POUNDS	WASTE DESCRIPTION
Category B Wastes					
Lab Pack	551	---	36	400	Consists mainly of expired and off-spec chemicals

--- No data available. Waste was either not generated or not a major waste stream on that reporting year.

C. Factors Affecting Waste Generation at Walsh Campus

Intel had a chemical lab inventory cleaning and eliminated expired and off-spec chemicals in 2002.

D. Source Reduction Activities

In 1998, Intel's Mission Campus had an overall normalized waste reduction of 71 percent when the two and half-fold increase in production is considered. However, in 2002, the facility's waste generation increased by 60 percent when normalized (wafer start increased 1.6 times). This increase was mostly from its waste streams processed in the wastewater treatment unit, which had a 128 percent increase. The other wastes (Category B wastes) had a 45 percent normalized reduction. Intel attributed this overall increase to the start of new processes in their operations.

The Bowers Campus achieved a 42 percent waste reduction in 1998 compared with 1994 when normalized. Also, implementation of various source reduction measures resulted in another 64 percent reduction when the increase in 2002 production is considered.

The source reduction measures implemented at Intel's three campuses are collectively discussed below.

1. Bulk Solvent Waste (CWC 212)

- *Substituted solvent cleaning with aqueous slurry blast cleaning*

The slurry blast process replaced IPA and acetone for cleaning dry etch tools. The process is a self-contained system which uses a slurry of very fine alumina grit and water. The system operates in a closed loop and is free of dust and chemicals. Slurry is directed through a special high volume vortex pump to the blast gun where regulated air pressure can be added to increase the level of aggressiveness of the process. Cleaning is accomplished by slurry flow over the part. The slurry particles and water are recirculated within the unit. A pump picks up and feeds the slurry from a sump through an abrasion resistant hose to the process gun.

Compared with 1994, Intel reduced its acetone use in 1998 by about 84 percent (3,515 pounds in 1998 versus 22,710 pounds in 1994). Also, IPA use was reduced by 80 percent (4,170 pounds in 1998 versus 20,420 pounds in 1994).

- *Reduction of water in bulk solvent waste tank*

The main components of the bulk solvent waste stream are water, N-methyl-pyrrolidinone (NMP), PRS 3000 (which contains 60 percent NMP), and other solvents such as IPA, ethanol, acetone, and methanol. There was about 65 percent water in this waste stream. Intel investigated and audited the tools to identify the sources of the unwanted water. Sources of unwanted water were corrected, and in 2002, Intel achieved a 41 percent reduction when its bulk solvent waste quantity decreased to 278,251 pounds from 473,415 pounds in 1998.

- *Use of DI water in wipe-down operations*

Intel eliminated acetone and IPA in many wipe-down operations by using deionized water. DI water produced acceptable results in many cases. The disadvantage of using DI water or water/solvent mixtures instead of pure solvents is that water evaporates more slowly and the equipment takes longer to dry. Intel, however, felt that the reduction in solvent usage outweighs this disadvantage.

IPA usage was further reduced by eliminating ten percent DI water/IPA mixture and 75 percent pre-saturated wipers and instead, using six percent DI water/IPA pre-saturated wipers. This resulted in 67 percent reduction in IPA consumption.

2. Solid Corrosive Waste and Ion Exchange Resins (CWC 181)

- *Elimination of carbon exchange resins*

The carbon exchange resins were previously used for removing total organic compounds (TOCs) from entering the zeolite bottles. The zeolite bottles have a resin that reduces the amount of lead in throughput, and it was believed that TOCs reduce the effectiveness of the zeolite bottles, and needed to be removed ahead of the zeolite bottles. However, Intel's experimental study showed that carbon resins do not affect the effectiveness of the zeolite bottles, and therefore were eliminated from the process.

3. Ninety-Six Percent Sulfuric Acid (CWC 135)

- *Conversion of wet bench tools*

By developing entirely new wet benches in cooperation with their equipment suppliers, Intel reduced its sulfuric acid use in the wafer fabrication process. Intel did not provide additional details on how the new benches differ from the old ones that effected acid use reduction.

Overall, Intel achieved a 23 percent reduction in sulfuric acid use in 1998 (310,380 pounds) compared with 1994 (403,880 pounds). Because of the new wet benches, ultra pure water was also reduced by 50 percent.

4. Mixed Photoresist Solvents

- *Spin coating optimized*

Spin coating is the standard method of applying photoresist to a wafer. The wafer is held on a turntable where a measured amount of chemical is dispensed on to it from a nozzle. Initially, the wafer may or may not be spinning. Once the chemical is dispensed, the spin speed is increased to spread the chemical over the surface. The thickness and uniformity of the photoresist layer is critical to the success for the pattern transfer. With Intel's product quality driven improvement in spin coating techniques, Intel was able to reduce its photoresist waste by 76 percent from 1994 to 1998 (175,810 pounds versus 42,210 pounds) and seven percent from 1998 to 2002 (from 42,210 pounds down to 39,264 pounds). These reductions do not yet include the effect of increased production in those years.

In addition to the above source reduction practices, Intel installed multiple segregated waste collection systems to recycle wastes offsite. PRS 3000, a photoresist stripper mixture which contains n-methyl-pyrrolidinone (NMP), was segregated in drums and shipped to an off-site supplier for recycling. The offsite supplier is the same supplier whom Intel purchases recycled PRS 3000. Similarly, ethylene glycol, a solvent used to clean silicon wafers, was segregated in drums for recycling offsite.

In various process areas, chemical usage in baths had been reduced by filtration and recirculation. Hydrofluoric acid mixtures were filtered and recirculated to extend bath life. A combined filtration and recirculation unit can be retrofitted to an existing wet station, or specified as part of a new wet station. The unit is known as FARM (Filtered Acid Recirculating Module), and removes not only particulates but also copper and silver ions.

Intel commented that in addition to hydrofluoric mixtures, there are other bath mixtures that could potentially be recirculated and filtered. However, the types of filtration medium to be used need to be investigated since there are different contaminants to remove. Also, there is the problem of monitoring the bath when the mixture is spent since on some applications, it is the active chemical content of the bath that determines bath life, and no such monitoring equipment is currently available commercially.

When purchasing new equipment, Intel follows environmental guidelines. It specifies certain environmental criteria that its equipment suppliers have to meet. One example was when it was selecting an isopropyl drier. Initially, the vendors' standard equipment did not meet Intel's emission criteria. Upon receiving Intel's specifications, vendors offered to add a condenser that would reduce IPA emissions below Intel's specifications.

MICREL SEMICONDUCTOR
San Jose, California

A. Company Background

Micrel Semiconductor is a manufacturer of Power, Connect and Protect IC solutions for the worldwide analog, Ethernet and high bandwidth markets. The company's products include advanced mixed-signal, analog and power semiconductors; high performance communication, clock management, Ethernet switch and physical layer transceiver ICs. Corporation headquarters and wafer fabrication facilities are located in San Jose, California where it has been in operation since 1993. Micrel employs approximately 850 people at the site. Micrel's Wafer Fab Operations was certified ISO 14001:1996 in 2004.

B. Major Wastes Generated

WASTES	CWC	2001 WEIGHT, POUNDS	2002 WEIGHT, POUNDS	WASTE DESCRIPTION
Category A				
Wastewater	134	8,138,235,000	6,292,022,000	From various acid baths, rinses, and dryers used in wet etching and wet cleaning
Category B				
Water with HF	135	587,870	225,455	From cleaning organic contaminants from the wafer
EKC Posistrip	343	86,694	76,987	Photoresist stripping
Mixed Solvents	214	42,159	32,072	From several process areas, but primarily from photoresist and etch areas
Subtotal (Category B Wastes)		716,723	334,514	
TOTAL Wastes (Category A + B)		**8,138,951,723**	**6,292,356,514**	

C. Factors Affecting Waste Generation

The wafer outputs at Micrel have decreased since 2001. Micrel produced 160,192 wafers in 2001 and 126,287 in 2002. This equates to a production decrease of 21 percent.

D. Source Reduction Activities

Micrel, after factoring in the 21 percent decrease in production, reduced all of its waste quantities in 2002 when compared with 2001 quantities except for the EKC posistrip waste. Overall, waste quantity was reduced to two percent, which was dominated by the volume of wastewater which had a two percent reduction. Considering only the Category B wastes (without the wastewater), waste reduction would be 41 percent.

Micrel reported that it evaluated its rinsing operations and looked at the minimum rinses required that would provide adequate rinse so as not to adversely impact product quality. Micrel was able to reduce the rinse cycle from seven cycles to five cycles, thus reducing the volume of its wastewater. Micrel also installed spray developers to replace the batch developers with dump rinse, which resulted in further wastewater reduction

As for its source reduction activities planned over the next four years, Micrel will implement the development of a maintenance checklist and preventive maintenance procedures. Maintenance technicians could ensure that all elements are considered when performing process equipment maintenance, maintain proper operation of equipment, and reduce equipment failures. This would reduce generation of several waste streams such as water with HF, EKC wastes, and mixed solvent wastes.

Other measures considered for specific waste streams include:

1. Wastewater

Various acid baths, rinses, and dryers used in wet etching and wet cleaning are sources of this waste stream. These sources discharge to the acid waste neutralization system.

To reduce wastewater generation, Micrel will look at extending EKC bath life, including the addition of hydroxylamine (HDA) to maintain the baths' cleaning capability. Micrel expects to reduce wastewater volume by about 4,900,000 pounds per year with this measure.

Micrel also expects to reduce the discharge to its wastewater neutralization system by about 1,000 gpd if timers are installed on aspirators which would eliminate the possibility of technicians leaving the valve in the open position. This would also reduce the amount of chemicals used in the treatment system.

2. Water with HF

Cleaning organic contaminants from the wafers during diffusion, post ion implantation, pre-metal deposition, pre-epitaxy deposition, and etching processes generates water with hydrofluoric acid. The waste is pumped to the acid lift station and into an aboveground storage tank.

Micrel will look at extending hydrofluoric acid bath life from 96 hours of use to a maximum of 200 hours. With this change, Micrel expects to reduce the HF waste by about 2,000 gallons.

3. EKC Posistrip

The EKC Posistrip is used to strip the positive photoresist during the etching process. The waste is pumped to a solvent waste station, and then deposited into 55-gallon waste drums.

With the increase in bath life as discussed above, the EKC Posistrip wastes will also correspondingly decrease. Micrel expects to reduce the generation of waste EKC Posistrip by ten percent.

Micrel also will lower its inventory levels, and avoid wastes generated because of lot expirations.

Furthermore, Micrel will replace its current batch system technology with spray acid tool technology that will reduce the EKC wastes by 800 gallons. The spray acid tool is claimed to reduce chemical usage as well as deionized water usage.

4. Mixed Solvents

Mixed solvent wastes are generated in several process areas, but primarily in the photoresist, and etch areas.

Micrel improved the efficiency of its catch cup cleaning process in the photoresist area. IPA is used to clean residual photoresist that is collected in the catch cups of the spin tracks. The photoresist recipes were evaluated to ensure that only the minimum required amount of photoresist is used to process the wafers. This modification reduced the amount of IPA needed to clean the spin tracks. A process change was also implemented in the spin on glass (SOG) batching system where IPA used in the SOG process was reduced by 38 percent.

MICROSEMI CORPORATION
Santa Ana, California

A. Company Background

Microsemi Corporation manufactured a broad line of silicon diodes, a semiconductor device that passes electrical current in one direction and blocks or restricts current flow in the opposite direction. The major products manufactured were silicon rectifiers and zener diodes, primarily for military, aerospace, medical, and computer applications. The company's products were used in high-performance applications such as jet aircraft engines, test equipment, high temperature diodes used in oil drilling, computer switching, and memory diodes.

The Microsemi plant in Santa Ana, California, which had been in operation at this site since 1971, had approximately 500 full-time employees as of 2002. However, Microsemi systematically reduced its staffing levels in 2004 and anticipated final closure of its operations in 2005. Although the facility would be closed in 2005, its source reduction activities were still discussed in this report so that other facilities may benefit from Microsemi's source reduction experience.

B. Major Wastes Generated

WASTES	CWC	1994 WEIGHT, POUNDS	1998 WEIGHT, POUNDS	2002 WEIGHT, POUNDS	WASTE DESCRIPTION
Category A					
Ammonium Hydroxide	122	---	36,000	61,500	Used to neutralize etching acids
Hydrogen Fluoride	791	18,983	17,000	23,000	Etchant
Acid Etch	791	29,058	48,000	44,000	Etchant
Sulfuric Acid	791	11,910	16,500	17,000	Etchant
Nickel Sulfate	726	6,550	10,000	0	From nickel plating process
Hydrogen Peroxide	135		10,000	11,000	
TOTAL Category A Wastes		**66,501**	**137,500**	**156,500**	
Category B					
Cyanides	131	4,832	18,000	2,200	From silver etching process
Perchloroethylene	211	17,266	18,500	0	Wafer cleaning
Isopropyl Alcohol	212	24,571	18,000	22,000	Wafer cleaning, rinsing, drying
Methanol	212	12,527	10,000	4,200	Wafer cleaning, rinsing, drying
1,1,1-Trichloroethane	211	11,360	0	0	Eliminated
TOTAL Category B Wastes		**70,556**	**64,500**	**28,400**	
TOTAL Wastes (Category A+B)		**137,057**	**202,000**	**184,900**	

--- No data available. Waste was either not generated or not a major waste stream on that reporting year

C. Factors Affecting Waste Generation

From 1994 to 2002, Microsemi reported no significant changes in business activity that would affect waste generation.

D. Source Reduction Activities

1. Cyanides (131)

For years, the company had treated the small silver end caps and other silver components with a potassium cyanide etching solution to remove any possible irregularities on the surface. The supplier was contacted to investigate its process to produce end caps that would be smooth and clean as received. After some cooperative evaluation, Microsemi obtained caps that were clean and were used as received. The cyanide etching for the end caps was thus eliminated.

2. Perchloroethylene (CWC 211)

The major processes that generated the chlorinated solvent waste (primarily perchloroethylene) were vapor degreasing for wax removal, wafer cleaning, and photoresist stripping.

Microsemi previously used a wax coating to mask one side of the wafer from an acid etch. After etching, the wax was removed in a degreaser. Wax masking was replaced with a vinyl tape which has greatly reduced the use of degreasing solvents. Several tapes were investigated to replace the wax, and the polyethylene tape that was finally selected provided adequate masking from the acid and is easily removed with alcohol. No further degreasing was required.

Microsemi, prior to its closure, was evaluating the elimination of mounting wax during mesa etch to reduce the solvent needed to remove the wax. Photoresist was then used in the mesa etch to protect areas that were not to be etched. In the mesa etch, wafers were mounted on steel discs using wax and etched in a reactor using strong acid. After the etching process, wafers were mounted on a hot plate and the wax was removed with the use of the solvent Ensolve (n-propylbromide). The photoresist was then removed using the resist stripper, Nophenol. Microsemi envisioned the use of the same photoresist to protect the back side of the wafer. The use of wax and steel discs would be eliminated by re-designing the etch bath and the fixtures used to hold the wafers. Since no wax will be used, the wax removal solvent would be eliminated.

3. Isopropyl Alcohol (CWC 212) and Methyl Alcohol (CWC 212)

Isopropyl alcohol and methyl alcohol were used in wafer cleaning and drying.

To reduce this waste stream, Microsemi eliminated the methanol-drying step on the furnace tube cleaning operation. This reduced the methanol waste stream by 30 percent. The facility achieved additional reduction of the alcohol waste steam when it introduced spin drying for certain components instead of using alcohol as a drying agent. Reduction in the use of methanol in the marking area also resulted in reduced waste generation.

Microsemi also previously implemented the following measures:

- Reduced bath size and re-fixture to minimize loss of solution. This allowed more efficient bath use.
- Installed water resistivity meter to optimize rinse-cycle time which reduced aqueous wastes (DI water).
- Obtained new degreasers with lids, hoists, and automation to reduce perchloroethylene (PERC), Ensolve, and n-propylbromide.
- Conducted employee training on conservation and chemical handling.
- Modified chemical ordering and inventorying. Microsemi implemented just in time ordering to reduce major chemical inventories.
- Vacuum pumps with oil lubricated and sealed bearings were replaced with pumps that have oil-less type bearings.

SHELL SOLAR INDUSTRIES
Camarillo, California

A. Company Background

Shell Solar industries is in the business of manufacturing monocrystalline photovoltaic cells, CIS thin film photovoltaic panels, and finished modules of both types for commercial, industrial, government, domestic, and recreational use. It has been in operation at its Camarillo site for 25 years, and employs approximately 500 people.

B. Major Wastes Generated

WASTES	CWC	1994 WEIGHT, POUNDS	1998 WEIGHT, POUNDS	2002 WEIGHT, POUNDS	WASTE DESCRIPTION
Category B					
Alkaline Solution without Metals	122	6,237,280	5,646,040	5,623,569	Generated from the etch bath and caustic wet scrubbers
Waste Oil and Mixed Oil	221	1,689,320	1,702,020	248,680	Spent cutting oil from the wire saw/ingot cutting operations
Oil/Water Separator Sludge	222	---	---	3,268,880	Centrificate and still bottoms consisting of oily silicon carbide sludge; generated from the wire saw cutting oil recovery operation
Liquids with halogenated organic compounds	741	560	1,560	6,580	Spent solvent from equipment maintenance and repair activities
Liquids with pH$\leq$ 2	791	9,360	83,560	6,600	Spent acid from etching and cleaning operations.
TOTAL Wastes		**7,936,520**	**7,433,180**	**9,154,311**	

--- No data available. Waste was either not generated or not a major waste stream on that reporting year.

C. Factors Affecting Waste Generation

From 1994 to 1998, Shell solar had a 100 percent increase in wafer production. In 2002, wafer production increased by 112 percent compared with 1998 production.

D. Source Reduction Activities

1. Alkaline Solution without Metals (CWC 122)

Shell has increasingly automated and optimized its CZ Wetline, where silicon wafers are etched to remove surface damage, eliminating many sources of human error which could cause unnecessary etchant solution turnover. This has reduced the generation of waste alkaline solution.

Also, Shell adjusted the caustic wet scrubber cleaning schedules to minimize scrubber solution change-outs.

From 1998 to 2002, CWC 122 waste generation decreased 53 percent from 434 to 204 pounds per 1000 wafers manufactured, even though cell (wafer) production increased by 112 percent.

2. Waste Oil/Mixed Oil (CWC 221)

This waste is generated from the cutting of silicon ingots by multiple wires using an abrasive slurry consisting of oil and silicon carbide. In 2001, Shell Solar started reclaiming its used cutting oil onsite where the slurry is centrifuged to separate carbide and silicone grit from the oil. The oil is then redistilled and reused until spent. Although the cutting oil recovery process significantly reduced the generation of waste oil, it generated centrificate and still bottoms consisting of oily silicon carbide sludge disposed as CWC 222, oil/water separation sludge. This is sent offsite for thermal treatment.

One improvement that contributed to the decrease in waste generation per wafer produced is the use of newer sawing equipment that improved the ingot yield by having decreased wafer thickness. This process generated less waste for a given amount of cutting oil used.

In 2002, CWC 221 waste generation decreased 93 percent from 130 to 9 pounds per 10000 wafers manufactured when compared with 1998.

3. **Liquids with pH $\leq$ 2 (CWC 791**)

Since 1998, the use of acetic and hydrochloric acids in their Ingot & Wafer Cleaning process as well as in their damage and texture etch process was discontinued. The use of alternate materials (ND-7 for acetic acid, and hydrofluoric acid for hydrochloric acid) has been found to be effective. Since ND-7 and HF were existing process reagents, the benefit was a process simplification and reduction in waste generation.

Also, Shell Solar eliminated the use of the mixture of hydrofluoric and nitric acid to etch seed crystals for silicon ingot growth. The facility now receives silicon ingots from its plant in Vancouver, Washington, thus, the hydrogen fluoride/nitric acid waste stream is no longer generated.

These combined activities decreased CWC 791 waste generation in 2002 by 96 percent from 6.43 to 0.24 pounds per 1000 wafers manufactured as compared with 1998 production.

SKYWORKS SOLUTIONS, INCORPORATED
Newbury Park, California

A. Company Background

Skyworks Solutions, Incorporated manufactures semiconductors for wireless communication devices. The semiconductors are made on a gallium arsenide substrate. The site primarily manufactures power amplifiers. As of July 2002, Skyworks has approximately 400 employees at the Newbury Park facility.

Skyworks has operated as a company since June 2002. Prior to that time, Conexant Systems (which spun off Skyworks as a separate company) operated the site from December 1998 to June 2002. Prior to that, Rockwell Semiconductor (which spun off Conexant as a separate company) operated the site from 1985-1998.

B. Major Wastes Generated

WASTES	CWC	1994 WEIGHT, POUNDS	1998 WEIGHT, POUNDS	2002 WEIGHT, POUNDS	WASTE DESCRIPTION
Category A					
Industrial Wastewater	131	Not evaluated	16,080,000	394,961,693	From photo developing and etching processes
Category B					
Spent Solvents	212	13,744	239,877	131,737	Used to lift off photoresist and metals from wafer
Arsenic Contaminated Debris	181	220	11,055	35,155	
Water With Arsenic	721	---	---	4,401,698	Generated from thinning of Gallium Arsenide wafers
NMP Solvent Waste	212	---	---	336,042	
TOTAL Category B Wastes		**13,964**	**250,932**	**4,904,632**	

--- No data available. Waste was either not generated or not a major waste stream on that reporting year.

C. Factors Affecting Waste Generation

Conexant increased production by approximately 465 percent from 1994 to 1998. The facility also attempted to use a new cleaning solvent, ST-33, but proved to be unsuccessful. This caused an increase in the amount of waste solvent generated.

There was again a production activity increase from 1998 to 2002. Wafer starts per week (WSPW) in 1998 were approximately 300. Production increased to an average of 954 WSPW in 2002, a 318 percent production activity increase.

D. Source Reduction Activities

1. Industrial Wastewater (131)

Dry etch tools were used more in 2002 than in 1998. Wet etch processes are a significant contributor to industrial waste water. Dry etch tools eliminate the use of aqueous hazardous materials for etch and eliminates the use of DI water for rinse. Skyworks still uses wet etch, and will pursue maximizing use of dry etch technology.

Skyworks, at the time it prepared its SB 14 reports, had an ongoing installation of recirculation filtration systems as new wet benches are purchased. This should increase bath lives and reduce wastewater.

2. Arsenic Contaminated Debris (CWC 181)

Since 1998, work has been done to limit the locations where arsenic cleaning takes place. This centralized cleaning practice resulted in an overall decrease of the waste stream by 49 percent based on production normalization.

3. Water With Arsenic (CWC 721)

This waste is generated when gallium arsenide wafers are thinned to desired thickness. Using a spinning abrasive chuck, wafers are thinned while being sprayed with water to keep the gallium arsenide particles from becoming airborne.

Skyworks planned on installing a grinder water filtration and recirculation system that would nearly eliminate this waste stream by reusing the water following filtration. Recovered gallium arsenide from the filter will be sold and recycled off-site.

4. NMP Waste (CWC 212)

Skyworks recognized that water contamination in captured NMP solvent waste accounts for approximately 24 percent of the waste by weight. The water contamination results from DI rinse processes, and Skyworks aimed to reduce the water content of the waste by adequately diverting the rinse water to the industrial waste water treatment system. This will subsequently reduce the quantity of NMP solvent waste generated.

VITESSSE SEMICONDUCTOR CORPORATION
Camarillo, California

A. Company Background

Vitesse Semiconductor Corporation specialized in semiconductor or integrated circuits research and development. Processes performed at the facility include wafer fabrication, photoresist and other coating operations, stripping, etching, ion implanting, and metal deposition.

B. Major Wastes Generated

WASTES	CWC	1994 WEIGHT, POUNDS	1998 WEIGHT, POUNDS	2002 WEIGHT, POUNDS	WASTE DESCRIPTION
Category A					
Aqueous Wastes	134 135	---	11,875	14,750	Generated from wafer/equipment cleaning
Category B					
Wastewater with HF	134	74,134	22,680	24,964	From wafer etching/cleaning operations
Waste Solvents	214	43,076	44,999	17,757	Comprised of waste photoresist strip, NMP, alcohol, acetone

--- No data available. Waste was either not generated or not a major waste stream on that reporting year.

C. Factors Affecting Waste Generation

Vitesse had a 74 percent increase in wafer starts from 1994 to 1998. However, Vitesse had gone through a lot of changes between 1998 and 2002. It transitioned from a manufacturing facility to a research and development facility. Comparing the wafer starts in 1998 from 2002, there was a significant decrease of 90 percent.

D. Source Reduction Measures Implemented

1. Aqueous Wastes (CWC 134, 135)

This waste stream is generated during various wafer and equipment cleaning operations. This includes rinse water from several wet benches and wastewater from deionized water manufacturing process.

- *Modified schedule of bath changes*

Instead of a routine schedule on a certain day of the week, bath changes were made based on the number of wafers processed.

- *Installed recirculation filters systems*

In order to extend the useful life of the HF solutions, recirculation filter systems were installed in the cleaning and etching baths. This recirculation system continually removes contaminants from the bath and thereby enables the solution to be used for a long period of time.

2. Wastewater with HF (CWC 134)

This waste is generated during processing and cleaning of the wafers in the wafer manufacturing process. Sources include waste rinse water from wafer etching processes conducted at several cleaning sinks throughout the assembly and fab areas. It is discharged to the HF etch and container rinsing sinks.

To reduce this waste stream, Vitesse implemented the following measures:

- It minimized the fill rate on the filling of the dump rinsers. Dump rinsers are used for rinsing after an etch operation, and have a continuous water overflow to prevent bacterial growth. By reducing the fill rate, water consumption is reduced.

- HF was replaced with sodium hydroxide in the shield cleaning process. The former process used HF, water and hydrogen peroxide. The new method uses hydrogen peroxide and water and then sodium hydroxide and water which completely eliminated the used of HF in the process.

- Similar to the measures implemented for the aqueous wastes, Vitesse performed bath changes less frequently, and were done based on the number of wafers processed instead of a routine schedule on a certain day.

- HF-containing wastewater from the HF sinks and the first dump rinsers had a high concentration of fluoride ions, whereas the wastewater from the second and third dump rinsers had a low concentration. Ion exchange columns were installed to remove the fluoride from the waste rinse water from the second and third dump rinse waters. The reclaimed water was then reused as make-up water in the cooling towers, fume scrubbers, and the reverse osmosis system used in the fab.

- Vitesse installed recirculation filter system to extend the life of HF solution. The recirculation filter system continually removes contaminants from the bath enabling the solution to be used for longer periods.

- Before, a cleaning sink was plumbed to both the waste fluoride tank and the neutralization system, and was equipped with a switching valve that would switch between the two. However, it was discovered that not all sink users were aware of the dual drain capacity. Initially, the potential sink user were informed of the valve changing procedure, and taught which chemicals contained fluoride. Eventually, the dual drain system was reconfigured to send the spent waste to the waste fluoride system only and the valve was removed. This eliminated the potential for a mistake.

3. Waste Solvents

This waste stream consisted of waste photoresist strip, NMP, alcohol, and acetone.

- *Vent fog jet gun installed*

Acetone and alcohol consumption was reduced by installing a vent fog jet gun to dispense the solvents which reduced the quantity of solvent going to the waste solvent collection tank by 90 percent.

- *Spin rate optimized*

The amount of overspray was reduced by optimizing the spin rate on the spin-on application process. With less overspray on the equipment, less solvent is needed to clean it.

- *Improved photoresist dispensing*

Before, photoresist was dispensed manually where it required operators to decide when to replace a bottle of photoresist that was in use with a full bottle. In order not to interrupt the dispensing process, operators would replace the bottles before they are completely empty, resulting in unused photoresist. Automatic dispensing was designed into the facility, and a positive displacement pump was installed to dispense photoresist onto the wafer and reduce the quantity of residual photoresist remaining in the container.

- *Dry pump used*

Used oil was generated during regular maintenance of vacuum pumps. The use of dry oil-less pumps significantly reduced the generation of waste oil.

APPENDICES

APPENDIX A. ACRONYMS AND ABBREVIATIONS

AWNS	Acid Waste Neutralization System
BOE	Buffered Oxide Etch
CMP	Chemical Mechanical Polishing
CMS	Chemical Management Services
CVD	Chemical Vapor Deposition
CWC	California Waste Code
DI	Deionized
DTSC	Department of Toxic Substances Control
EPA	Environmental Protection Agency
HF	Hydrofluoric Acid
HMDS	Hexamethyldisilane
HWTS	Hazardous Waste Tracking System
IPA	Isopropyl alcohol
LED	Light Emitting Diodes
NAICS	North American Industry Classification System
NMP	n-Methyl-Pyrrolidinone
PERC	Perchloroethylene
PGMEA	Propylene Glycol Monomethyl Ether Acetate
PPE	Personnel Protective Equipment
POTW	Publicly Owned Treatment Works
RO	Reverse Osmosis
SIC	Standard Industry Code
SB 14	Hazardous Waste Source Reduction and Management Review Act of 1989
SPM	Sulfuric Acid and Hydrogen Peroxide Mixture
SOG	Spin on Glass
SPR	Summary Progress Report
TOC	Total Organic Compound
TSD	Treatment, Storage, and Disposal
UV	Ultraviolet
VPE	Vapor Phase Epitaxy

APPENDIX B. SB 14 LAW

Excerpts from the Health & Safety Code, Division 20, Chapter 6.5, Article 11.9

25244.12. This article shall be known and may be cited as the Hazardous Waste Source Reduction and Management Review Act of 1989.

25244.13. The Legislature finds and declares as follows:

(a) Existing law requires the department and the State Water Resources Control Board to promote the reduction of generated hazardous waste. This policy, in combination with hazardous waste land disposal bans, requires the rapid development of new programs and incentives for achieving the goal of optimal minimization of the generation of hazardous wastes. Substantial improvements and additions to the state’s hazardous waste reduction program are required to be made if these goals are to be achieved.

(b) Hazardous waste source reduction provides substantial benefits to the state’s economy by maximizing use of materials, avoiding generation of waste materials, improving business efficiency, enhancing revenues of companies that provide products and services in the state, increasing the economic competitiveness of businesses located in the state, and protecting the state’s precious and valuable natural resources.

(c) It is the intent of the Legislature to expand the state’s hazardous waste source reduction-activities beyond those directly associated with source reduction evaluation reviews and plans. The expanded program, which is intended to accelerate reduction in hazardous waste generation, shall include programs to promote implementation of source reduction measures using education, outreach, and other effective voluntary techniques demonstrated in California or other states.

(d) It is the intent of the Legislature for the department to maximize the use of its available resources in implementing the expanded source reduction program through cooperation with other entities, including, but not limited to, CUPAs, small business development corporations, business environmental assistance centers, and other regional and local government environmental programs. To the extent feasible, the department shall utilize cooperative programs with entities that routinely contact small business to expand its support of small business source reduction activities.

(e) It is the goal of this article to do all of the following:

(1) Reduce the generation of hazardous waste.

(2) Reduce the release into the environment of chemical contaminants which have adverse and serious health or environmental effects.

(3) Document hazardous waste management information and make that information available to state and local government.

(f) It is the intent of this article to promote the reduction of hazardous waste at its source, and wherever source reduction is not feasible or practicable, to encourage recycling. Where it is not feasible to reduce or recycle hazardous waste, the waste should be treated in an environmentally safe manner to minimize the present and future threat to health and the environment.

(g) It is the intent of the Legislature not to preclude the regulation of environmentally harmful releases to all media, including air, land, surface water, and groundwater, and to encourage and promote the reduction of these releases to air, land, surface water, and groundwater.

(h) It is the intent of the Legislature to encourage all state departments and agencies, especially the State Water Resources Control Board, the California regional water quality control boards, the State Air Resources Board, the air pollution control districts, and the air quality management districts, to promote the reduction of environmentally harmful releases to all media.

25244.14. For purposes of this article, the following definitions apply:

(a) “Advisory committee” means the California Source Reduction Advisory Committee established pursuant to Section 25244.15.1.

(b) “Appropriate local agency” means a county, city, or regional association that has adopted a hazardous waste management plan pursuant to Article 3.5 (commencing with Section 25135).

(c) “Hazardous waste management approaches” means approaches, methods, and techniques of managing the generation and handling of hazardous waste, including source reduction, recycling, and the treatment of hazardous waste.

(d) “Hazardous waste management performance report” or “report” means the report required by subdivision (b) of Section 25244.20 to document and evaluate the results of hazardous waste management practices.

(e)(1) “Source reduction” means one of the following:

(A) Any action that causes a net reduction in the generation of hazardous waste.

(B) Any action taken before the hazardous waste is generated that results in a lessening of the properties which cause it to be classified as a hazardous waste.

(2) “Source reduction” includes, but is not limited to, all of the following:

(A) “Input change,” which means a change in raw materials or feedstocks used in a production process or operation so as to reduce, avoid, or eliminate the generation of hazardous waste.

(B) “Operational improvement,” which means improved site management so as to reduce, avoid, or eliminate the generation of hazardous waste.

(C) “Production process change,” which means a change in a process, method, or technique which is used to produce a product or a desired result, including the return of materials or their components, for reuse within the existing processes or operations, so as to reduce, avoid, or eliminate the generation of hazardous waste.

(D) “Product reformulation,” which means changes in design, composition, or specifications of end products, including product substitution, so as to reduce, avoid, or eliminate the generation of hazardous waste.

(3) “Source reduction” does not include any of the following:

(A) Actions taken after a hazardous waste is generated.

(B) Actions that merely concentrate the constituents of a hazardous waste to reduce its volume or that dilutes the hazardous waste to reduce its hazardous characteristics.

(C) Actions that merely shift hazardous wastes from one environmental medium to another environmental medium.

(D) Treatment.

(f) “Source reduction evaluation review and plan” or “review and plan” means a review conducted by the generator of the processes, operations, and procedures in use at a generator’s site, in accordance with the format established by the department pursuant to subdivision (a) of Section 25244.16, and that does both of the following:

(1) Determines any alternatives to, or modifications of, the generator’s processes, operations, and procedures that may be implemented to reduce the amount of hazardous waste generated.

(2) Includes a plan to document and implement source reduction measures for the hazardous wastes specified in paragraph (1) that are technically feasible and economically practicable for the generator, including a reasonable implementation schedule.

(g) “SIC Code” has the same meaning as defined in Section 25501.

(h) “Hazardous waste,” “person,” “recycle,” and “treatment” have the same meaning as defined in Article 2 (commencing with Section 25110).

25244.15.

(a) The department shall establish a program for hazardous waste source reduction pursuant to this article.

(b) The department shall coordinate the activities of all state agencies with responsibilities and duties relating to hazardous waste and shall promote coordinated efforts to encourage the reduction of hazardous waste. Coordination between the program and other relevant state agencies and programs shall, to the fullest extent possible, include joint planning processes and joint research and studies.

(c) The department shall adopt regulations to carry out this article.

(d)(1) Except as provided in paragraph (3), this article applies only to generators who, by site, routinely generate, through ongoing processes and operations, more than 12,000 kilograms of hazardous waste in a calendar year, or more than 12 kilograms of extremely hazardous waste in a calendar year.

(2) The department shall adopt regulations to establish procedures for exempting generators from the requirements of this article where the department determines that no source reduction opportunities exist for the generator.

(3) Notwithstanding paragraph (1), this article does not apply to any generator whose hazardous waste generating activity consists solely of receiving offsite hazardous wastes and generating residuals from the processing of those hazardous wastes.

25244.15.1.

(a) The California Source Reduction Advisory Committee is hereby created and consists of the following members:

(1) The Executive Director of the State Air Resources Board, as an ex officio member.

(2) The Executive Director of the State Water Resources Control Board, as an ex officio member.

(3) The Director of Toxic Substances Control, as an ex officio member.

(4) The Executive Director of the Integrated Waste Management Board, as an ex officio member.

(5) The Chairperson of the California Environmental Policy Council established pursuant to Section 71017 of the Public Resources Code, as an ex officio member.

(6) Ten public members with experience in source reduction as appointed by the department.. These public members shall include all of the following:

(A) Two representatives of local governments from different regions of the state.

(B) One representative of a publicly owned treatment works.

(C) Two representatives of industry.

(D) One representative of small business.

(E) One representative of organized labor.

(F) Two representatives of statewide environmental advocacy organizations.

(G) One representative of a statewide public health advocacy organization.

(7) The department may appoint up to two additional public members with experience in source reduction and detailed knowledge of one of the priority categories of generators selected in accordance with Section 25244.17.1.

(b) The advisory committee shall select one member to serve as chairperson.

(c) The members of the advisory committee shall serve without compensation, but each member, other than officials of the state, shall be reimbursed for all reasonable expenses incurred in the performance of his or her duties, as authorized by the department.

(d) The advisory committee shall meet at least semiannually to provide a public forum for discussion and deliberation on matters pertaining to the implementation of this chapter.

(e) The advisory committee's responsibilities shall include, but not be limited to, the following:

(1) Reviewing and providing consultation and guidance in the preparation of the work plan required by Section 25244.22.

(2) Evaluating the performance and progress of the department's source reduction program.

(3) Making recommendations to the department concerning program activities and funding priorities, and legislative changes, if needed.

(f) The advisory committee established by this section shall be in existence until April 15, 2002, by which date the department shall, in consultation with the advisory committee, evaluate the role and activities of the advisory committee and determine if the committee is beneficial to the implementation of this article. On and after April 15, 2002, the advisory committee shall continue to exist and operate to the extent that the department, in consultation with the advisory committee, determines the advisory committee continues to be beneficial to the operation of the department's source reduction programs.

25244.16. The department shall do both of the following:

(a) Adopt a format to be used by generators for completing the review and plan required by Section 25244.19, and the report required by Section 25244.20. The format shall include at least all of the factors the generator is required to include in the review and plan and the report. The department may include any other factor determined by the department to be necessary to carry out this article. The adoption of a format pursuant to this subdivision is not subject to Chapter 3.5 (commencing with Section 11340) of Part 1 of Division 3 of Title 2 of the Government Code.

(b) Establish a data and information system to be used by the department for developing the categories of generators specified in Section 25244.18, and for processing and evaluating the source reduction and other hazardous waste management information submitted by generators pursuant to Section 25244.18. In establishing the data and information system, the department shall do all of the following:

(1) Establish methods and procedures for appropriately processing or managing hazardous waste source reduction and management information.

(2) Use the data management expertise, resources, and forms of already established environmental protection programs, to the extent practicable.

(3) Establish computerized data retrieval and data processing systems, including safeguards to protect trade secrets designated pursuant to Section 25244.23.

(4) Identify additional data and information needs of the program.

25244.17. The department shall establish a technical and research assistance program to assist generators in identifying and applying methods of source reduction and other hazardous waste management approaches. The program shall emphasize assistance to smaller businesses that have inadequate technical and financial resources for obtaining information, assessing source reduction methods, and developing and applying source reduction techniques. The program shall include at least all of the following elements, which shall be carried out by the department:

(a) The department shall encourage programs by private or public consultants, including onsite consultation at sites or locations where hazardous waste is generated, to aid those generators requiring assistance in developing and implementing the review and plan, the plan summary, the report, and the report summary required by this article.

(b) The department shall conduct review and plan assistance programs, seminars, workshops, training programs, and other similar activities to assist generators to evaluate source reduction alternatives and to identify opportunities for source reduction.

(c) The department shall establish a program to assemble, catalogue, and disseminate information about hazardous waste source reduction methods, available consultant services, and regulatory requirements.

(d) The department shall identify the range of generic and specific technical solutions that can be applied by particular types of hazardous waste generators to reduce hazardous waste generation.

25244.17.1. The department shall establish a technical assistance and outreach program to promote implementation of model source reduction measures in priority industry categories.

(a) Every two years, in the work plan required by Section 25244.22, the department shall, in consultation with the advisory committee, select at least two priority categories of generators by SIC Code. At least one selected category of generators shall be taken from the list of categories previously selected by the department under Section 25244.18. At least one selected category of generators shall be a category that consists primarily of small businesses.

(b) For each selected priority industry category, the department shall implement a cooperative source reduction technical assistance and outreach program to include the following elements:

(1) The department shall use available resources, including reports prepared pursuant to paragraph (4) of subdivision (a) of Section 25244.18 and information on source reduction methods from federal, state, and local governments and industry associations and industry members, to identify a set of model source reduction measures for each industry category.

(2) The department shall determine, with the assistance of the advisory committee, the most effective technical assistance and outreach methods to promote implementation of the model source reduction measures identified in paragraph (1).

(3) The department shall develop a plan and schedule to implement the technical assistance and outreach measures before the next biennial work plan. The measures may include, but are not limited to, all of the following:

(A) Holding, presenting at, or cosponsoring workshops, conferences, technology fairs, and other promotional events.

(B) Developing and distributing educational materials, such as short descriptions of successful source reduction projects.

(C) Developing checklists, training manuals, technical resource manuals and using those resources to train CUPAs, small business development corporations, business environmental assistance centers, and other regional and local government environmental programs.

(D) Preparing and distributing resource lists, such as lists of vendors, consultants, or providers of financial assistance for source reduction projects.

(E) Serving as an information clearinghouse to support telephone and onsite consultations with businesses and local governments.

(4) For industry categories that include primarily large or technically complex businesses, the source reduction technical assistance and outreach program shall emphasize activities that involve direct communication between department staff and industry members. For these industry categories, the department shall communicate with representatives of 80 percent of the state's companies in the category. For categories that consist primarily of small businesses, the cooperative source reduction program shall emphasize providing industry-specific training and resources to CUPAs, small business development corporations, business environmental assistance centers, and other regional and local government environmental programs for use in their inspections and other direct communications with businesses.

(c) While conducting activities under this section, the department shall coordinate its activities with appropriate industry and professional associations.

(d) The department shall coordinate activities under this section with grants made under Sections 25244.5 and 25244.11.5.

25244.17.2. The department shall expand the department's source reduction program to provide source reduction training and resources to CUPAs, small business development corporations, business environmental assistance centers, and other regional and local government environmental programs so that they can provide technical assistance to generators in identifying and applying methods of source reduction.

(a) The program expanded pursuant to this section shall emphasize activities necessary to implement Sections 25244.17 and 25244.17.1.

(b) The department shall determine, in consultation with the advisory committee, the most effective methods to promote implementation of source reduction education programs by CUPAs, small business development corporations, business environmental assistance centers, and other regional and local government environmental programs. Program elements may include, but are not limited to, all of the following:

(1) Sponsoring workshops, conferences, technology fairs, and other training events.

(2) Sponsoring regional training groups, such as the regional hazardous waste reduction committees.

(3) Developing and distributing educational materials, such as short descriptions of successful source reduction projects and materials explaining how source reduction has been used by businesses to achieve compliance with environmental laws enforced by local governments.

(4) Developing site review checklists, training manuals, and technical resource manuals and using those resources to train CUPAs, small business development corporations, business environmental assistance centers, and other regional and local government environmental programs.

(5) Preparing and distributing resource lists such as lists of vendors, consultants, or providers of financial assistance for source reduction projects.

(6) Serving as an information clearinghouse to support telephone and onsite consultants with local governments.

(c) The department shall coordinate activities under this section with grants made under Section 25244.11.5.

(d) Each fiscal year, the department shall provide training and information resources to at least 90 percent of CUPAs.

25244.18.

(a) On or before September 15, 1991, and every two years thereafter, the department shall select at least two categories of generators by SIC Code with potential for source reduction, and, for each category, shall do all of the following:

(1) Request that selected generators in the category provide the department, on a timely basis, with a copy of the generator's completed review and plan and with a copy of the generator's completed report.

(2) Examine the review and plan and the report of selected generators in the category.

(3) Ensure that the selected generators in that category comply with Sections 25244.19 and 25244.20.

(4) Identify successful source reduction and other hazardous waste management approaches employed by generators in the category and disseminate information concerning those approaches to generators within the category.

(b) In carrying out subdivision (a), the department shall not disseminate information determined to be a trade secret pursuant to Section 25244.23.

(c) The department or the unified program agency may request from any generator, and the generator shall provide within 30 days from the date of the request, a copy of the generator's review and plan or report. The department or the unified program agency may evaluate any of those documents submitted to the department or the unified program agency to determine whether it satisfies the requirements of this article.

(d)(1) If the department or the unified program agency determines that a generator has not completed the review and plan in the manner required by Section 25244.19, or the report in the manner required by Section 25244.20, the department or the unified program agency shall provide the generator with a notice of noncompliance, specifying the deficiencies in the review and plan or report identified by the department. If the department or the unified program agency finds that the review and plan does not comply with Section 25244.19, the department or the unified program agency shall consider the review and plan to be incomplete. A generator shall file a revised review and plan or report correcting the deficiencies identified by the department or the unified program agency within 60 days from the date of the receipt of the notice. The department or the unified program agency may grant, in response to a written request from the generator, an extension of the 60-day deadline, for cause, except that the department or the unified program agency shall not grant that extension for more than an additional 60 days.

(2) If a generator fails to submit a revised review and plan or report complying with the requirements of this article within the required period, or if the department or unified program agency determines that a generator has failed to implement the measures included in the generator's review and plan for reducing the generator's hazardous waste, in accordance with Section 25244.19, the department or the unified program agency may impose civil penalties pursuant to Section 25187, in an amount not to exceed one thousand dollars ($1,000) for each day the violation of this article continues, notwithstanding Section 25189.2, seek an order directing compliance pursuant to Section 25181, or enter into a consent agreement or a compliance schedule with the generator.

(e) If a generator fails to implement a measure specified in the review and plan pursuant to paragraph (5) of subdivision (b) of Section 25244.19, the generator shall not be deemed to be in violation of Section 25244.19 for not implementing the selected measure if the generator does both of the following:

(1) The generator finds that, upon further analysis or as a result of unexpected consequences, the selected measure is not technically feasible or economically practicable, or if the selected approach has resulted in any of the following:

(A) An increase in the generation of hazardous waste.

(B) An increase in the release of hazardous chemical contaminants to other media.

(C) Adverse impacts on product quality.

(D) A significant increase in the risk of an adverse impact to human health or the environment.

(2) The generator revises the review and plan to comply with the requirements of Section 25244.19.

(f) When taking enforcement action pursuant to this article, the department or the unified program agency shall not judge the appropriateness of any decisions or proposed measures contained in a review and plan or report, but shall only determine whether the review and plan or report is complete, prepared, and implemented in accordance with this article.

(g) In addition to the unified program agency, an appropriate local agency that has jurisdiction over a generator's site may request from the generator, and the generator shall provide within 30 days from the date of that request, a copy of the generator's current review and plan and report.

25244.19.

(a) On or before September 1, 1991, and every four years thereafter, each generator shall conduct a source reduction evaluation review and plan pursuant to subdivision (b).

(b) Except as provided in subdivision (c), the source reduction evaluation review and plan required by subdivision (a) shall be conducted and completed for each site pursuant to the format adopted pursuant to subdivision (a) of Section 25244.16 and shall include, at a minimum, all of the following:

(1) The name and location of the site.

(2) The SIC Code of the site.

(3) Identification of all routinely generated hazardous waste streams that annually weigh 600 kilograms or more and that result from ongoing processes or operations and exceed 5 percent of the total yearly weight of hazardous waste generated at the site, or, for extremely hazardous waste, that annually weigh 0.6 kilograms or more and exceed 5 percent of the total yearly weight of extremely hazardous waste generated at the site. For purposes of this paragraph, a hazardous waste stream identified pursuant to this paragraph shall also meet one of the following criteria:

(A) It is a hazardous waste stream processed in a wastewater treatment unit that discharges to a publicly owned treatment works or under a national pollutant discharge elimination system (NPDES) permit, as specified in the Federal Water Pollution Control Act, as amended (33 U.S.C. Sec. 1251 and following).

(B) It is a hazardous waste stream that is not processed in a wastewater treatment unit and its weight exceeds 5 percent of the weight of the total yearly volume at the site, less the weight of any hazardous waste stream identified in subparagraph (A).

(4) For each hazardous waste stream identified in paragraph (3), the review and plan shall include all of the following information:

(A) An estimate of the quantity of hazardous waste generated.

(B) An evaluation of source reduction approaches available to the generator that are potentially viable. The evaluation shall consider at least all of the following source reduction approaches:

(i) Input change.

(ii) Operational improvement.

(iii) Production process change.

(iv) Product reformulation.

(5) A specification of, and a rationale for, the technically feasible and economically practicable source reduction measures that will be taken by the generator with respect to each hazardous waste stream identified in paragraph (3). The review and plan shall fully document any statement explaining the generator's rationale for rejecting any available source reduction approach identified in paragraph (4).

(6) An evaluation, and, to the extent practicable, a quantification, of the effects of the chosen source reduction method on emissions and discharges to air, water, or land.

(7) A timetable for making reasonable and measurable progress towards implementation of the selected source reduction measures specified in paragraph (5).

(8) Certification pursuant to subdivision (d).

(9) Any generator subject to this article shall include in its source reduction evaluation review and plan four-year numerical goals for reducing the generation of hazardous waste streams through the approaches provided for in subparagraph (B) of paragraph (4), based upon its best estimate of what is achievable in that four-year period.

(10) A summary progress report that briefly summarizes and, to the extent practicable, quantifies, in a manner that is understandable to the general public, the results of implementing the source reduction methods identified in the generator's review and plan for each waste stream addressed by the previous plan over the previous four years. The report shall also include an estimate of the amount of

reduction that the generator anticipates will be achieved by the implementation of source reduction methods during the period between the preparation of the review and plan and the preparation of the generator's next review and plan. Notwithstanding any other provision of this section, the summary progress report required to be prepared pursuant to this paragraph shall be submitted to the department on or before September 1, 1999, and every four years thereafter.

(c) If a generator owns or operates multiple sites with similar processes, operations, and waste streams, the generator may prepare a single multisite review and plan addressing all of these sites.

(d) Every review and plan conducted pursuant to this section shall be submitted by the generator for review and certification by an engineer who is registered as a professional engineer pursuant to Section 6762 of the Business and Professions Code and who has demonstrated expertise in hazardous waste management, by an individual who is responsible for the processes and operations of the site, or by an environmental assessor who is registered pursuant to Section 25570.3 and who has demonstrated expertise in hazardous waste management. The engineer, individual, or environmental assessor shall certify the review and plan only if the review and plan meet all of the following requirements:

(1) The review and plan addresses each hazardous waste stream identified pursuant to paragraph (3) of subdivision (b).

(2) The review and plan addresses the source reduction approaches specified in subparagraph (B) of paragraph (4) of subdivision (b).

(3) The review and plan clearly sets forth the measures to be taken with respect to each hazardous waste stream for which source reduction has been found to be technically feasible and economically practicable, with timetables for making reasonable and measurable progress, and properly documents the rationale for rejecting available source reduction, measures.

(4) The review and plan does not merely shift hazardous waste from one environmental medium to another environmental medium by increasing emissions or discharges to air, water, or land.

(e) At the time a review and plan is submitted to the department or the unified program agency, the generator shall certify that the generator has implemented, is implementing, or will be implementing, the source reduction measures identified in the review and plan in accordance with the implementation schedule contained in the review and plan. A generator may determine not to implement a measure selected in paragraph (5) of subdivision (b) only if the generator determines, upon conducting further analysis or due to unexpected circumstances, that the selected measure is not technically feasible or economically practicable, or if attempts to implement that measure reveal that the measure would result in, or has resulted in, any of the following:

(1) An increase in the generation of hazardous waste.

(2) An increase in the release of hazardous chemicals to other environmental media.

(3) Adverse impacts on product quality.

(4) A significant increase in the risk of an adverse impact to human health or the environment.

(f) If the generator elects not to implement the review and plan, including, but not limited to, a selected measure pursuant to subdivision (e), the generator shall amend its review and plan to reflect that election and include in the review and plan proper documentation identifying the rationale for that election.

25244.20.

(a) On or before September 1, 1991, and every four years thereafter, each generator shall prepare a hazardous waste management performance report documenting hazardous waste management approaches implemented by the generator.

(b) Except as provided in subdivision (d), the hazardous waste management performance report required by subdivision (a) shall be prepared for each site in accordance with the format adopted pursuant to subdivision (a) of Section 25244.16 and shall include all of the following:

(1) The name and location of the site.

(2) The SIC Code for the site.

(3) All of the following information for each waste stream identified pursuant to paragraph (3) of subdivision (b) of Section 25244.19:

(A) An estimate of the quantity of hazardous waste generated and the quantity of hazardous waste managed, both onsite and offsite, during the current reporting year and the baseline year, as specified in subdivision (c).

(B) An abstract for each source reduction, recycling, or treatment technology implemented from the baseline year through the current reporting year, if the reporting year is different from the baseline year.
(C) A description of factors during the current reporting year that have affected hazardous waste generation and onsite and offsite hazardous waste management since the baseline year, including, but not limited to, any of the following:
(i) Changes in business activity.
(ii) Changes in waste classification.
(iii) Natural phenomena.
(iv) Other factors that have affected either the quantity of hazardous waste generated or onsite and offsite hazardous waste management requirements.
(4) The certification of the report pursuant to subdivision (e).
(c) For purposes of subdivision (b), the following definitions apply:
(1) The current reporting year is the calendar year immediately preceding the year in which the report is to be prepared.
(2) The baseline year is either of the following, whichever is applicable:
(A) For the initial report, the baseline year is the calendar year selected by the generator for which substantial hazardous waste generation, or onsite or offsite management, data is available prior to 1991.
(B) For all subsequent reports, the baseline year is the current reporting year of the immediately preceding report.
(d) If a generator owns or operates multiple sites with similar processes, operations, and waste streams, the generator may prepare a single multisite report addressing all of these sites.
(e) Every report completed pursuant to this section shall be submitted by the generator for review and certification by an engineer who is registered as a professional engineer pursuant to Section 6762 of the Business and Professions Code and who has demonstrated expertise in hazardous waste management, by an individual who is responsible for the processes and operations of the site, or by an environmental assessor who is registered pursuant to Section 25570.3 and who has demonstrated expertise in hazardous waste management. The engineer, individual, or environmental assessor shall certify the report only if the report identifies factors that affect the generation and onsite and offsite management of hazardous wastes and summarizes the effect of those factors on the generation and onsite and offsite management of hazardous wastes.

25244.21.

(a) Every generator shall retain the original of the current review and plan and report, shall maintain a copy of the current review and plan and report at each site, or, for a multisite review and plan or report, at a central location, and upon request, shall make it available to any authorized representative of the department or the unified program agency conducting an inspection pursuant to Section 25185. If a generator fails, within five days, to make available to the inspector the review and plan or report, the department, the unified program agency, or any authorized representative of the department, or of the unified program agency, conducting an inspection pursuant to Section 25185, shall, if appropriate, impose a civil penalty pursuant to Section 25187, in an amount not to exceed one thousand dollars ($1,000) for each day the violation of this article continues, notwithstanding Section 25189.2.
(b) If a generator fails to respond to a request for a copy of its review and plan or report made by the department or a unified program agency pursuant to subdivision (c) of Section 25244.18, or by a local agency pursuant to subdivision (g) of Section 25244.18, within 30 days from the date of the request, the department or unified program agency shall, if appropriate, assess a civil penalty pursuant to Section 25187, in an amount not to exceed one thousand dollars ($1,000) for each day the violation of this article continues, notwithstanding Section 25189.2.
(c)(1) Any person may request the department to certify that a generator is in compliance with this article by having the department certify that the generator has properly completed the review and plan and report required pursuant to Sections 25244.19 and 25244.20. The department shall respond within 60 days to a request for certification. Upon receiving a request for certification, the department shall request from the generator, who is the subject of the request, a copy of the generator’s review and plan and report, pursuant to subdivision (c) of Section 25244.19, if the department does not have

these documents. The department shall forward a copy of the review and plan and report to the person requesting certification, within 10 days from the date that the department receives the request for certification or receives the review and plan and report, whichever is later. The department shall protect trade secrets in accordance with Section 25244.23 in a review and plan or report, requested to be released pursuant to this subdivision.
(2) This subdivision does not prohibit any person from directly requesting from a generator a copy of the review and plan or report. Solely for the purposes of responding to a request pursuant to this subdivision, the department shall deem the review and plan or report to be a public record subject to Section 25152.5, and shall act in compliance with that section.

25244.22. Commencing May 1, 2000, and on or before January 15 of every other year thereafter, the department shall prepare, and make available for public review within five days thereafter, a draft work plan for the department's operations and activities in carrying out this article. The department shall prepare the work plan in consultation with the advisory committee and with other interested parties, including local government, industry, labor, health, and environmental organizations. After holding a public meeting of the advisory committee to discuss the draft work plan, the department shall finalize the work plan on or before June 15, 2000, and on or before April 1 of every other year thereafter. The department may include this work plan within the report required pursuant to Section 25171. This work plan shall include, but not be limited to, all of the following information:

(a) A summary analysis of readily available data on the state's hazardous waste generation and management patterns. The analysis shall include information from various data sources including hazardous waste manifests, biennial generator reports, and United States Environmental Protection Agency Toxics Release Inventory reports. The department shall estimate the quantities of hazardous waste generated in the state, by hazardous waste stream, the amounts of hazardous waste generated in the state by industry SIC Code, and the amounts of hazardous waste state generators sent offsite for management, by management method.

(b) An evaluation of hazardous waste source reduction progress in this state, using the data summary analysis prepared pursuant to subdivision (a).

(c) Recommendations for legislation.

(d) Identification of any state, federal, or private economic and financial incentives that can best accelerate and maximize the research and development of source reduction and other hazardous waste management technologies and approaches.

(e) The status, funding, and results of all research projects.

(f) A detailed summary of the extent to which the statewide goal of 5 percent per year reduction of the generation of hazardous wastes, pursuant to subdivision (e) of Section 25244.15, has been attained, and a detailed summary of the extent to which different categories of facilities have attained the numerical goals established pursuant to paragraph (9) of subdivision (b) of Section 25244.19. This summary, which shall use the data summary analysis prepared pursuant to subdivision (a), shall include an evaluation by the department of the reasons why these goals have or have not been attained, including an evaluation of the impact of economic growth or decline and changes in production patterns, and a list of appropriate recommendations designed to ensure attainment of these goals.

(g) An outline of the department's operations and activities under this article proposed for the next two-year period. The department shall use the data summary analysis prepared pursuant to subdivision (a) to select hazardous waste stream and industries for source reduction efforts. When identifying activities for inclusion in the work plan, the department shall also consider potential benefits to human health and the environment, available resources, feasibility of applying source reduction techniques to reduce selected hazardous waste streams and to reduce hazardous wastes generated by selected industries, and availability of related resources from other entities, such as other states, the federal government, local governments, and other organizations.

25244.23.

(a)(1) The department shall adopt regulations to ensure that trade secrets designated by a generator in all or a portion of the review and plan or the report required by this article are utilized by the director, the department, the unified program agency, or the appropriate local agency only in connection with the responsibilities of the department pursuant to this article, and that those trade secrets are not otherwise disseminated by the director, the department, the unified program agency, or any authorized representative of the department, or the appropriate local agency, without the consent of the generator.

(2) Any information subject to this section shall be made available to governmental agencies for use in making studies and for use in judicial review or enforcement proceedings involving the person furnishing the information.

(3) As provided by Section 25159.5, the regulations adopted pursuant to this subdivision shall conform with the corresponding trade secret regulations adopted by the Environmental Protection Agency pursuant to the federal act, except that the regulations adopted by the department may be more stringent or more extensive than the federal trade secret regulations.

(4) “Trade secrets,” as used in this section, may include, but are not limited to, any formula, plan, pattern, process, tool, mechanism, compound, procedure, production data, or compilation of information that is not patented, that is known only to certain individuals within a commercial concern who are using it to fabricate, produce, or compound an article of trade or a service having commercial value, and that gives its user an opportunity to obtain a business advantage over competitors who do not know or use it.

(b) The department, the unified program agency, and the appropriate local agency shall protect from disclosure any trade secret designated by the generator pursuant to this section. The department shall make available information concerning source reduction approaches that have proved successful, and that do not constitute a trade secret, when carrying out subdivision (c) of Section 25244.17 and to subdivision (a) of Section 25244.18.

(c) This section does not permit a generator to refuse to disclose the information required pursuant to this article to the department, the unified program agency, or the appropriate local agency, an officer or employee of the department, the unified program agency, or the appropriate local agency, in connection with the official duties of that officer or employee under this article.

(d) Any officer or employee of the department, the unified program agency, or the appropriate local agency, or any other person, who, because of his or her employment or official position, has possession of, or has access to, confidential information, and who, knowing that disclosure of the information to the general public is prohibited by this section, knowingly and willfully discloses the information in any manner to any person not entitled to receive it, is guilty of a misdemeanor and, upon conviction thereof, shall be punished by imprisonment in the county jail not exceeding six months, by a fine not exceeding one thousand dollars ($1,000), or by both the fine and imprisonment..

25244.24.

(a) For purposes of this section the following definitions shall apply:

(1) “Program” means the voluntary program to reduce hazardous waste generation established by this section.

(2) “Release” means a release of a chemical into the environment in any manner and by any means. “Release” includes, but is not limited to, any release authorized or permitted pursuant to a statute, ordinance, regulation, or rule of any federal, state, local, or regional agency or government or by a permit, license, variance or other authorization from the agency or government.

(b) On or before October 1, 2000, the department shall, in consultation with the advisory committee established pursuant to Section 25244.15.1, conduct an inventory and analysis of low-cost voluntary programs that are, or have been conducted by other states, the federal government, or local government entities to reduce hazardous waste generation and other environmental releases of toxic chemicals, and shall develop recommendations for programs that would be effective and feasible in California, based on the inventory and analysis.

(c) In consultation with the advisory committee, large businesses, and the public, the department shall develop a low-cost voluntary program to further reduce generation of hazardous waste by large businesses in California. The program shall be designed to promote cooperative relationships between

California business and the department, while creating a significant environmental benefit from reduced hazardous waste generation. The department shall include the program in the work plan required by Section 25244.22 on or before January 15, 2002.

(d) In designing and implementing the program the department shall take into consideration all of the following:

(1) Estimates of the volumes of potential reductions of hazardous waste generation and other possible program benefits.

(2) The types of facilities expected to participate and their current hazardous waste generation and other releases of toxic chemicals into the environment.

(3) The potential for reductions in hazardous waste generation resulting in an increase in releases of toxic chemicals to a different environmental medium.

(4) The potential public health and environmental benefits of the program.

(5) Methods for publicizing the program and encouraging facilities throughout the state to participate in the program.

(6) Providing appropriate public recognition of facilities that successfully are participating in the program.

(7) Establishing a means for monitoring the progress that each facility participating in the program is making toward implementing the program.

(8) Establishing methods for evaluating the implementation of the inventory, analysis, and program and for reporting on the progress of the program in the work plan required pursuant to Section 25244.22.

(9) Procedures for providing technical support to program participants to assist with the implementation of the program.

(e) Participation in the program shall not create a presumption that the participating facility has determined that any chemical release reduction measure is technically feasible or economically practicable pursuant to any other provision of law.

(f) Actions of the department pursuant to this section are exempt from the requirements of Chapter 3.5 (commencing with Section 11340) of Division 3 of Title 2 of the Government Code.

(g) If, on the basis of the inventory and analysis required by in subdivision (b), the department finds that it is not possible to design and implement, at relatively low cost, a voluntary program to promote cooperative relationships between California business and the department, while creating a significant environmental benefit, and the advisory committee concurs with this finding, the department is not required to implement the program.

APPENDIX C. SB 14 REGULATIONS

The following excerpts are from California Code of Regulations, Title 22, Division 4.5, Chapter 31

§67100.1. Definitions.
For the purpose of this article, the following definitions shall apply:

(a) "Appropriate local agency" means a county, city, or regional association which has adopted a hazardous waste management plan pursuant to Article 3.5, Chapter 6.5, Division 20, Health and Safety code (commencing with Section 25135).

(b) "Baseline year" is any of the following, whichever is applicable:

(1) For a generator's initial report, the baseline year is the calendar year, selected by the generator, for which substantial hazardous waste generation, or onsite or offsite management data is available, except the generator may select the current reporting year as the baseline year for the initial report.

(2) For all subsequent reports, the baseline year is the reporting year of the immediately preceding report.

(c) "Concentration" means the amount of a given substance in a stated unit of mixture, solution or waste. For purposes of this article it also means the range of components typically found in the waste.

(d) "Hazardous waste management approaches" means methods and techniques of controlling the generation and handling of hazardous waste, including source reduction, recycling, and treatment of hazardous waste.

(e) "Hazardous waste management performance report" or "report" means the report required by section 67100.7(a) of these regulations to document and evaluate the results of hazardous waste management practices.

(f) “Laboratory” means a facility where the “laboratory use of hazardous chemicals” occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis.

(g) “Laboratory scale” means work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safely manipulated by one person. “Laboratory scale” excludes those workplaces whose function is to produce commercial quantities of material.

(h) “Laboratory use of hazardous chemicals” means handling or use of such materials in which all of the following conditions are met:

(1) Chemical manipulations are carried out on a “laboratory scale”;

(2) Multiple chemical procedures or chemicals are used; and

(3) The procedures involved are not part of a production process, nor in any way simulate a production process.

(i) "Motor vehicle fluids" includes all fluids associated with the operation of a vehicle that is self propelled, for example, transmission oil, hydraulic fluid, brake fluid, antifreeze, power steering fluid, and gasoline.

(j) "Numerical Goal" means a single numerical percentage reflecting an estimate of the source reduction the generator could optimally strive to achieve over a four-year period.

(k) "Reporting year" is the calendar year immediately preceding the year in which plans, reports, and compliance checklist are to be prepared.

(l) "Routinely generated" means:

(1) Hazardous and extremely hazardous wastes that result from ongoing processes or operations.

(2) Hazardous wastes generated from regularly scheduled maintenance or production activities performed less frequently than once a year.

(m) "Small business" means "small business" as defined in Government Code, Section 11342(e).

(n) "Source reduction" means one of the following:

(1) Any action which causes a net reduction in the generation of hazardous waste.

(2) Any action taken before the hazardous waste is generated that results in lessening of the properties which cause it to be classified as a hazardous waste.

(o) "Source reduction evaluation review and plan" or "review and plan" or "plan" means a review conducted by the generator of the processes, operations, and procedures in use at a generator's site, required pursuant to Section 67100.4(a) completed according to the format established by the Department of Toxic Substances Control in Section 67100.5 of these regulations. Plans do both of the following:

(1) Determine any alternatives to, or modifications of, the generator's processes, operations, and procedures that may be implemented to reduce the amount of hazardous waste generated.

(2) Include a plan to document and implement source reduction measures for the hazardous wastes specified in paragraph (1) which are technically feasible and economically practicable for the generator, including a reasonable implementation schedule.

§67100.2. Applicability.

(a) This article applies to generators who, by site, routinely generate, through ongoing processes and operations, more than 12,000 kilograms of hazardous waste in the reporting year, or more than 12 kilograms of extremely hazardous waste in a reporting year.

(b) A generator may petition the Department of Toxic Substances Control in writing to exempt a hazardous waste stream. The generator shall provide documentation to demonstrate that no source reduction opportunities exist for the requested waste stream exemption. The Department of Toxic Substances Control shall public notice the proposed acceptance of any exemption petition. A minimum of 45 days shall be provided for public review and comment prior to the Department of Toxic Substances Control rendering any determination on a petition.

(c) The following hazardous wastes shall not be included in calculating the volume, or comparable weight of waste produced and are not subject to this article:

(1) The following exempted hazardous waste streams:

(A) Motor vehicle fluids and motor vehicle filters.

(B) Lead acid batteries.

(C) Household hazardous wastes, wastes from household collection events and wastes separated at community landfills.

(D) Waste pesticides and pesticide containers collected by County agricultural commissioners.

(E) Spent munitions and ordnance.

(F) Decommissioned utility poles.

(G) Oil generated from decommissioned refrigeration units.

(H) Mercury relays and low-level radioactive tubes generated from removal of telephone equipment..

(I) Lighting wastes including ballasts and fluorescent tubes.

(2) The following hazardous waste streams that are not routinely generated:

(A) Waste from site cleanup and mitigation activities including remedial investigations.

(B) Samples and evidence from enforcement actions.

(C) Asbestos.

(D) PCBs

(E) Formation fluids and solids from oil, gas and geothermal exploration and field development.

(F) Demolition waste/major renovation waste.

(G) Waste generated from emergency response actions.

(H) Waste generated from laboratory scale research.

(3) Medical Waste.

(d) When there is a change in ownership of the business, institution, or facility, the new owner shall have six months from the date of purchase to amend or rewrite the plan and the report. If the new owner fails to revise the plan and report during this time, the existing plan and report shall remain in effect.

(e) When there is a change in the state or federal analysis and testing criteria which causes additional materials to be classified as hazardous waste, these newly classified hazardous wastes shall be considered in calculating the volume, or comparable weight of hazardous waste produced at the generator's site starting the next reporting year.

(f) Any generator that is a small business may complete the forms contained in the documents listed below and include Sections 1, 3, 4, 5, and 6 of the Compliance Checklist Form, September 1993, or January 1997, as the plan. Documents for specific industries are available from the Department of Toxic Substances Control. The generator's most recent biennial report, as required by Section 66262.41 can be used as the report required by this article. The following are available from the Department of Toxic Substances Control and are hereby incorporated by reference:

(1) Waste Audit Study -- Automotive Repairs, May, 1987

(2) Waste Audit Study -- Automotive Paint Shops, January, 1987

(3) Waste Audit Study -- General Medical and Surgical Hospitals, August, 1988

(4) Waste Audit Study -- Paint Manufacturing Industry, April, 1987

(5) Waste Audit Study -- Drug Manufacturing and Processing Industry, May, 1989

(6) Waste Audit Study -- Metal Finishing Industry, May, 1988

(7) Waste Audit Study -- Pesticide Formulating Industry, November, 1987

(8) Waste Audit Study -- Research and Educational Institutions, August, 1988

(9) Waste Audit Study -- Photoprocessing Industry, April, 1989

(10) Waste Audit Study -- Fiberglass-Reinforced and Composite Plastic Products, April, 1989

(11) Waste Audit Study -- Marineyards for Maintenance and Repair, August, 1989

(12) Waste Audit Study -- Building Construction Industry, May, 1990

(13) Waste Audit Study -- Fabricated Metal Products Industry, August, 1989

(14) Waste Audit Study -- Gold, Silver, Platinum, and Other Precious Metals Product and Reclamation, June, 1990

(15) Waste Audit Study – Mechanical Equipment Repair Shops, May, 1990

(16) Hazardous Waste Minimization Checklist & Assessment Manuals -- Automotive Repair Shops, October, 1988

(17) Hazardous Waste Minimization Checklist & Assessment Manuals -- Metal Finishing Industry, September, 1989

(18) Waste Audit Study -- Printed Circuit Board Manufacturers, June, 1987

(19) Waste Audit Study – Commercial Printing Industry, May, 1989

(20) Waste Audit Study -- Thermal Metal Working Industry, December, 1990

(21) Hazardous Waste Minimization Checklist & Assessment Manuals -- Pesticide Formulators, June, 1990

(22) Facility Pollution Prevention Guide, EPA/600/R-92/088, May, 1992

(g) Any generator that is a small business may alternatively complete the Compliance Checklist Form, September 1993, or January 1997, developed by the Department of Toxic Substances Control as the Plan.

(h) If a generator owns or operates multiple sites with similar processes, operations, and wastes the generator may prepare a single multisite Review and Plan, Report, or Compliance Checklist addressing all of these sites.

(i) If a generator owns a large site with multiple operations that are managed as independent businesses, the generator may prepare a separate Review and Plan, Report, or Compliance Checklist for each independently managed business at the site.

(j) Generators subject to the requirements of this article pursuant to Section 67100.4(a) and 67100.7(a) may prepare a single document combining the requirements for the Plan and the Report.

§67100.3. Availability Requirements.

(a) Every generator shall retain a copy of the current Review and Plan, Report, Summary Progress Report and Compliance Checklist at each site, or, for a multisite at a central location, and upon request, shall make it available to any authorized representative of the Department of Toxic Substances Control and any other officer or agency conducting an inspection pursuant to Section 25185 of the Health and Safety Code.

(b) A copy of the Plan, Report and Summary Progress Report and Compliance Checklist shall be made available locally for public review. This may be accomplished by making documents available at the generator's facility, at a public library or at the offices of any local governmental agency which is willing to act as a repository for this information. If any of the above documents contain trade secrets, then a copy which excludes trade secrets shall be made available locally for public review.

§67100.4. Plan.

(a) On or before September 1, 1991 and every four years thereafter that hazardous or extremely hazardous waste generation exceeds the thresholds in Section 67100.2(a) of these regulations, each generator shall conduct a source reduction evaluation Review and Plan pursuant to Section 67100.5 of these regulations.

(b) Except as provided in Sections 67100.2(h) and 67100.2(i) of these regulations, a source reduction evaluation Review and Plan shall be prepared for each site.

(c) At the time a Review and Plan is submitted to the Department, the generator shall certify that the generator has implemented, is implementing, or will be implementing, the source reduction measures identified in the Review and Plan according to the implementation schedule contained in the Review and Plan. A generator may determine not to implement a source reduction measure selected in Section 67100.5(m) of these regulations only if the generator determines, upon conducting further analysis or due to unexpected circumstances, that the selected measure is not technically feasible or economically practicable, or if attempts to implement that measure reveal that the measure would result in, or has resulted in, any of the following:

(1) An increase in the generation of hazardous waste.

(2) An increase in release of hazardous chemicals to other environmental media.

(3) Adverse impacts on product quality.

(4) A significant increase in the risk of an adverse impact to human health or the environment.

(d) If the generator elects not to implement the Review and Plan, including, but not limited to, a selected measure pursuant to Section 67100.5(m) of these regulations, the generator shall amend its review and plan within 90 days to reflect this rejection and include in the review and plan proper documentation identifying the rationale for this rejection.

§67100.5. Plan Format.

Except as provided in Section 67100.2(f) of these regulations, generators subject to the requirements of this article pursuant to Section 67100.2(a), shall prepare a Plan with sufficient detail to convey an understanding of the source reduction evaluation review and analysis performed, using narratives, photographs, illustrations, figures or data as necessary, which includes, but is not limited to, all of the following:

(a) Name and location of the site, telephone number and Identification Number.

(b) Four digit SIC codes applicable to activities at the site.

(c) Type of business or activity conducted at each site.

(d) Length of time the company has been in business at the present site.

(e) Major products manufactured or services provided and, if necessary to convey an understanding of the business, their general applications or examples of their applications or end use.

(f) Number of employees.

(g) A general description of site operations with corresponding block diagrams focusing on quantity and type of hazardous wastes, raw materials, and final products produced at the site.

(h) Identification of all routinely generated hazardous waste streams in the current reporting year which result from ongoing processes or operations that have a yearly volume, or comparable weight exceeding five percent of the total yearly volume, or comparable weight of hazardous waste generated at the site, or, for extremely hazardous waste, five percent of the total yearly volume, or comparable weight generated at the site. Similar industrial processes or institutional activities generating similar wastes (with the same California Waste Codes) shall be considered a single waste stream for purposes of this subsection.

(i) All of the following information for each hazardous waste stream identified in subsection (h) of this section:

(1) An estimate of the weight, in pounds of hazardous waste generated.

(2) The applicable California waste code.

(3) The processes, operations and activities generating the waste(s), with corresponding block diagrams to illustrate the basis of generation including a listing of all input materials which contribute to the generation of hazardous or extremely hazardous waste (this is not meant to be a mass balance).

(j) An evaluation of source reduction measures available to the generator which are potentially viable. The evaluation shall consider at least all of the following approaches:

(1) Input changes.

(2) Operational improvement.

(3) Production process changes.

(4) Product reformulation.

(5) Administrative steps taken to reduce hazardous waste generation including but not limited to:

(A) Inventory control;

(B) Employee award programs;

(C) Employee training;

(D) In-house policies;

(E) Corporate or management commitment; and

(F) Other programs or measures.

(k) Consideration of the following factors for each measure evaluated in accordance with subsection (j) of this section (where a specific factor does not apply identify as N/A):

(1) Expected change in the amount of hazardous waste generated;

(2) Technical feasibility;

(3) Economic evaluation:

(A) Capital cost, operating cost, waste management cost;

(B) Return on investment (ROI), breakdown point, avoided cost, pretax payback period, or any other economic comparison method;

(4) Effects on product quality;

(5) Employee health and safety implications;

(6) Permits, variances, compliance schedules or applicable state local and federal agencies;

(7) Releases and discharges.

(l) Any pertinent information, such as waste stream constituents and concentration of constituents, needed to evaluate and implement source reduction measures.

(m) A specification of, and a rationale for, the technically feasible and economically practicable source reduction measures which will be taken by the generator with respect to each hazardous waste stream identified in subsection (h) of this section. The specification should include at a minimum, a narrative description of the factors in subsection (k) of this section and also address system capacity and efficiency. Photographs, illustrations, figures or data should be used to convey an understanding of the source reduction measure in sufficient detail to allow transfer of the measure to other generators with similar processes or procedures.

(n) An evaluation, and, to the extent practicable, a qualification of the effects of any source reduction measure selected in subsection (m) on emissions and discharges to air, water, or land.

(o) A list of each measure considered but not selected for a detailed evaluation as a potentially viable source reduction measure. For each measure rejected, explain the generator's rationale. This list shall be supplemented for waste streams where no measures were identified with a narrative demonstrating the good faith efforts undertaken to identify measures.

(p) A timetable for making reasonable and measurable progress towards implementation of the selected source reduction measures specified in subsection (m) of this section. It shall also include an implementation schedule for completing the evaluation of potentially viable source reduction measures and it shall prioritize processes and wastes for future research, development and source reduction analysis.

(q) All plans prepared after January 1, 1993 shall contain a four-year numerical goal for reducing the generation of hazardous waste streams through the selected source reduction measures specified in subsection (m) of this section.

§67100.7. Report.

(a) On or before September 1, 1991, and every four years thereafter that hazardous or extremely hazardous waste generation exceeds the thresholds in Section 67100.2(a) of these regulations, each generator shall prepare a hazardous waste management performance report pursuant to Section 67100.8 of these regulations.

(b) Except as provided in Sections 67100.2(h) and 67100.2(i) of these regulations, the hazardous waste management performance report shall be prepared for each site.

§67100.8. Report Format.

(a) Except as provided in Section 67100.2(f) of these regulations and in subsection (b) of this section, each generator shall prepare a report with sufficient detail to convey an understanding of the hazardous waste management approaches used at the site, using narratives, photographs, illustrations, figures or data as necessary, which includes, at a minimum, all of the following:

(1) Name and location of the site

(2) Four digit SIC code(s) for the site

(3) All of the following information for each waste stream identified pursuant to Section 67100.5(h) of these regulations:

(A) An estimate, in pounds, of the quantity of hazardous waste generated and the quantity of hazardous waste managed, both onsite and offsite, during the current reporting year and the baseline year.

(B) A description of current hazardous waste management approaches and identification of all approaches implemented since the baseline year.

(C) An assessment of the effect, since the baseline year, of each implemented hazardous waste management approach on the weight of hazardous waste generated the properties which cause it to be classified as a hazardous waste and/or the onsite and offsite management of hazardous waste. The report shall consider, but shall not be limited to all of the following approaches:

1. Source reduction;
2. Onsite or offsite recycling;
3. Onsite or offsite treatment.

(D) A description of factors during the current reporting year that have affected hazardous waste generation and onsite and offsite hazardous waste management since the baseline year, including, but not limited to, any of the following:

1. Changes in business activity;
2. Changes in waste classification;
3. Natural phenomena and;
4. Other factors that have affected either the quantity of hazardous waste generated or onsite and offsite hazardous waste management requirements.

(b) If the generator selects the current reporting year as the baseline year, the information required pursuant to subsection (a)(3) of this section shall be provided for the reporting year only.

67100.9. Summary Progress Report.

(a) Generators subject to the requirements of this article shall prepare a Summary Progress Report and submit it to the Department of Toxic Substances Control on or before September 1, 1999 and every four years thereafter.

(b) Generators shall complete the Department of Toxic Substances Control's Form #1262 (12/02) titled, "Summary Progress Report" as their summary progress report. This document is incorporated by reference.

(c) The director, in consultation with the Secretary for Environmental Protection, shall, within five years of the effective date of the regulations in this section, determine whether the regulations should be retained, revised, or repealed.

§67100.13. Certification Requirements.

(a) The Review and Plan, Report, and Compliance Checklist, completed pursuant to this article shall be reviewed by an engineer who is registered as a professional engineer pursuant to Section 6762 of the Business and Professions Code, by an individual who is responsible for the processes and operations of the site, or by an environmental assessor who is registered pursuant to Section 25570 Health and Safety Code.

(b) The engineer, individual, or environmental assessor shall certify the Review and Plan only if the Review and Plan meet all of the following requirements:

(1) The Review and Plan addresses each hazardous waste stream identified pursuant to Section 67100.5(h) of these regulations.

(2) The Review and Plan addresses the source reduction approaches specified in Section 67100.5(j) of these regulations.

(3) The Plan clearly sets forth the measures to be taken with respect to each hazardous waste stream for which source reduction has been found to be technically feasible and economically practicable, with timetables for making reasonable and measurable progress, and documents the rationale for rejecting available source reduction measures.

(4) The Plan does not merely shift hazardous waste from one environmental medium to another environmental medium by increasing emissions or discharges to air, water, or land.

(c) The engineer, individual, or environmental assessor shall certify that Compliance Checklist has been completed.

(d) The engineer, individual, or environmental assessor shall certify the Report only if the Report meets the following requirement:

(1) The Report identifies factors that affect the generation and onsite and offsite management of hazardous wastes and summarizes the effect of those factors on the generation and onsite and offsite management of hazardous wastes.

(e) The Plan, Report, and Compliance Checklist shall contain the following language signed and dated by either the owner, the operator, or the responsible corporate officer of the site or an authorized individual; who is capable of committing financial resources necessary to implement the source reduction measures:

"I certify that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or the persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for making false statements or representations to the Department, including the possibility of fines for criminal violations."

§67100.14. Trade Secrets.

(a) Any information submitted to the Department pursuant to this article may be claimed as confidential by the generator. Any such claim shall be asserted at the time of submission by placing the words "confidential business information" on each page containing such information. If no claim is made at the time of submission, the Department shall make the information available to the public without further notice. If a claim is asserted, the information shall be treated in accordance with 40 CFR Part 2 and the Health and Safety Code, Sections 25173 and 25244.23.

(b) If a claim of confidentiality is asserted, two versions of the document shall be submitted: one version with the confidential pages and one version without the confidential pages but with a clear indication of which pages are removed as confidential.